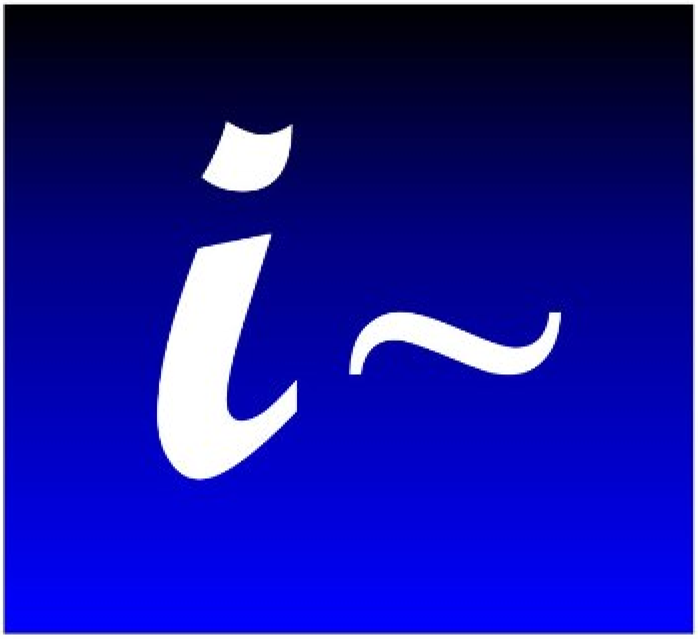
diagramma

Antonella Canonico and Gabriele Rossi

Semi-Immortality



The indefinite extension of human life

Collana Diagramma

Antonella Canonico and Gabriele Rossi

SEMI-IMMORTALITY

The indefinite extension of life

Translation by Camilla Peroni

Contents

… to our daughter Marta

Presentation

At some point in the course of its history, humankind will reach immortality. We believe that this moment is approaching at a fast pace and that it will manifest itself by the end of this century.

From a strictly scientific point of view, we will not speak of immortality, but rather of the "indefinite prolongation of life", i.e. semi-immortality. Since the extension of human life-span will be a gradual occurrence developing progressively day after day, discovery after discovery, we deem it possible that some among the readers of this book will actually enjoy the opportunity to become semi-immortal.

Thirty years ago our research laboratory of artificial intelligence and psychoneurophysiology came to light. Combined with genetics and nanosciences, it will precisely be these two disciplines to provide the most significant technological contributions to the indefinite prolongation of human life. We are now able to present a complete and coherent path that, in our opinion, will lead to semi-immortality. Not only from a scientific and technological standpoint, but also, and perhaps most importantly, from a philosophical perspective.

This book primarily aims at looking for travel companions.

Antonella Canonico and *Gabriele Rossi*

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PRELUDE

Prelude

In a Time difficult to pinpoint and in a Space difficult to specify, one or more Intelligences several orders of magnitude superior to ours decided to amuse themselves and generated one or more Universes.

During the elapse of Time within the Universes one or more Systems developed and initiated one or more Games.

Each Universe is composed of one or more Base Elements and one or more Fundamental Laws. Recursive combinations of the Elements and the Laws determine all possible Systems.

Within our Universe, nearly four billion years ago, on planet Earth the first Intelligent Systems developed, i.e. systems capable of elaborating non-univocous responses to external stimuli.

Within our Universe, roughly one million years ago, on planet Earth the first Systems Man emerged and began to take part in the Game.

The Game consists in coming to utterly understand the rules of the Game itself, the Prize will be Immortality and the Complete Solution to the Game will enable the Systems realizing it to approach the Originative Intelligences.

Ever since his appearance Man has been building Machines for the purpose of assisting him in the attainment of the Complete Solution to the Game.

The Artificial-Selves we shall construct will be one of these Machines.

2. The Semi-Immortality Research Laboratory

Immortal, eternal, everlasting. The adjective "immortal" means "that which cannot die" and, by extension, "that which will have no end". Then, there are terms that come close to this meaning: for instance, "eternal" recalls something possessing neither a beginning nor an end, therefore something that is bound to last over time, forever. It is extremely challenging to mentally shift into a perspective of immortality. We wonder whether we have in our brain the space, and thus the logical categories, which can truly adapt our mind to eternity.

We live in a sort of eternal illusion, as in our deepest self we know that nothing is so. Since there has never been a real possibility of immortality (if not the religious one of the immortality of the soul), who knows if its attainment will lead us to happiness or to misery. Man is mortal, the soul is not. This is all that underlies our historical, genetic, evolutionary experience; for thousands of years man has developed his knowledge driven by the finiteness of time available to him, he has had children at an early age because otherwise there wouldn't be enough time, he has sought success, sex, money... because afterwards he wouldn't have any chance. It is very likely that a heavy and relevant concept of the time factor is rooted in our genetic heritage and that it is not to be underestimated in a new vision of "internal time" and "external time".

We are accustomed to the concept of eternal time as a time that has always existed; in the end, it is man who beats its rhythm. In a context of eternity, the time factor resets or, on the contrary, expands a concept of time/pace that, for the time being, does not belong to the human mind, if not under particular conditions (displacements and/or alterations of consciousness). And so what? To us, as scientists who study the mind, the question is, to what logical, emotional, environmental categories should we assign the new cerebral and thus behavioural functioning? Technological evolution led us to get our brain accustomed to a concept of acceleration and simultaneous expansion (we can be anywhere annulling distance and time). Will the next years be a sufficient time span to allow for the formation of instruments in some area of our brain enabling us to adapt to these non-definable, dilated, viable spaces? We believe that the answer is affirmative. Technology on one hand, diseases on the other, the questioning of religious ideas and the establishment of science operated a change on the brain of new generations and developed different skills in the older generations, thereby preparing them to such a conceptual jump.This is what solicited our interest in these new scenarios of "everlasting intelligence". It is truly fascinating to understand and discover what inherited (i.e. those written in the DNA) mental characteristics will survive death and what will instead perish by natural selection. What categories will dreams, projects, objectives fall into? Will they still exist? Because these are related to a particular time. And what about feelings, unions, monogamy, procreation?Will new diseases coexist with the old ones, will the concepts of immanence and transcendence still make sense if a sought-after paradise or an escaped-from hell no longer exist?

2.1 The Solution to the Game

What crucially drove us to expose ourselves and, for the first time in our lives, to undertake the path of popularization, besides that of research, treatment and entrepreneurial activity is probably the conviction developed over the last months that we are approachng to the Solution to the Game. We are not alone in thinking this. Other researchers deem immortality or at least semi-immrtality, i.e. an indefinite extension of human life, possible. What is new is that in these very hours some of them, just like us, consider it within reach[1]. We thought it was important to spread the word and, from a selfish-generational point of view, to start to take all possible actions aimed at accelerating the events. We would be sorry if we came to miss the train of semi-immortality for just a few minutes. But even if that were the case, nevertheless we would like at least our daughter to be able to grasp it benefits.

This book has the ambitious goal to provide information concerning some of the main instruments that will allow us to progress towards the Solution to the Game in the next thirty-forty years. Therefore, it is necessarily a complex book, not so much because it explores difficult or unknown topics, but more because its main purpose is to provide a thorough and robust vision of everything that surrounds us and, basically, to give a coherent answer to any question we may ask. Obviously, we will not advance a definitive understanding; in fact, that will be attained only when we are much closer to the Solution to the Game than we are today. Nonetheless, we will put forward what, from our standpoint, we believe to be currently the most correct approach to be adopted in the perspective of achieving semi-immortality. What we demand from the interested reader is patience and trust. Patience because we will deal, and often in an unconventional fashion, with issues that our current culture tends to treat in an uncorrelated manner. Hence, many readers will need a considerable amount of time before they begin to truly understand something. The award we hope to grant in return for such patience is a key to the interpretation of reality which is also useful in everyday life, but first and foremost a walk into dimensions of thought that are prevalently beyond people's common range of experience. We believe that these dimensions of thought, besides being enjoyable and adventurous, are precisely the ideal ones to begin the path to semi-immortality.

From our point of view, the only thing we are able to guarantee is that this book is an honest book. We are both fully accomplished in our daily entrepeneurial and professional activity and thus we don't have any particular gratification to attain, any specific fideistic theses to support nor economic interests to pursue. We simply felt it was just time to start to disseminate the work we have accomplished so far, with the hope to provide further contributions to the Solution to the Game while trying to persuade as many people as possible to engage into this exciting venture.

2.2 Instructions for reading the book: the three minds

As we shall analyse later on, one of our fundamental tenets is that the human mind is made up of different forms of reasoning operating distinctly from one another. Since we are still in an introductory phase, more weight should be given to effectiveness rather than formal rigour, so we can assert that, in a sense, we have "three minds". We find it appropriate to mention this idea at this point not only because we consider it as essential to the understanding of the human mind, but also for the very good reason that it represents one of the crucial keys to the interpretation of our book. The first substantial step is to begin conceiving the human mind not as a single structure, but as a set of related modules, each specialized in specific tasks. Different modules can be identified depending on the interpretative angle one may want to offer. From a purely functional perspective we believe that a convenient starting point is to begin conceiving the human mind as composed of at least three distinct minds.

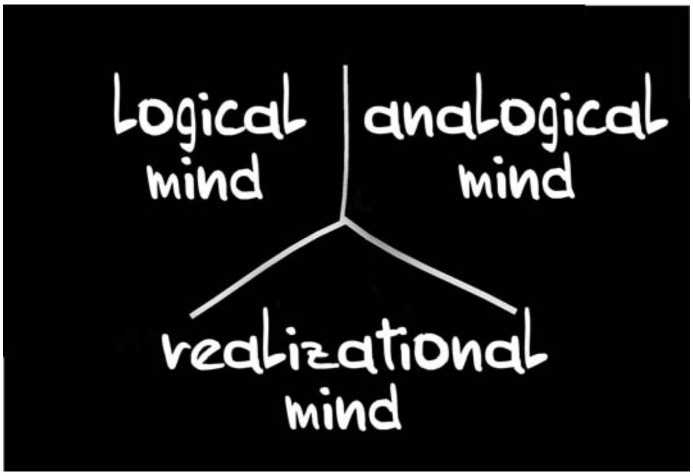

Fig. 2.1. The "3 minds" of man.

First, we have the "logical" mind that is essentially based on analytical reasoning criteria. For this module the fundamental parameters are consistency and accuracy. The more a person is able to be logical the better she will be at performing tasks such as calculus, abstraction or direction. The main feature of this module is lucidity. If, besides being lucid, a person has an excellent memory and is exceptionally quick, she will be perceived by others as a "scientific genius". Often, we tend to correlate intelligence to this module. We can affirm that the logical mind is specialized in the understanding of causes.

The undisputable relevance of the logical module must not lead us to forget that it is not the only mind we have available. There also exists the "analogical" mind that is basically rooted on associative reasoning criteria. For this module the key parameters are similarity and the measure of distance. The more a person is able to be analogical the better she will be at performing tasks such as linguistic, expressive or imaginative ones. The main feature of this module is laterality. If, besides being highly lateral, a person has an excellent memory and is exceptionally quick she is generally perceived by others as an "artistic genius". Often, we tend to correlate creativity to this module. We can state that the analogical mind is specialized in the understanding of effects.

Finally, there is the "realizational" mind that is fundamentally founded on operational reasoning criteria. For this module the basic parameters are the performance of a task and forward-thinking ability. The more a person is able to be realizational the better she will be at performing leadership, organizational or entrepreneurial tasks. The main feature of this module is the attitude for planning. If, besides being a planner, a person has an excellent memory and is exceptionally quick she is generally perceived by others as an "entrepreneurial (or political, or military, etc...) genius". We can assert that the realizational mind is specialized in the implementation of projects.

Have you been patient enough to read and try to understand this first classification? Here is the reward. Each person possesses these three modules and starts off with an original endowment that is determined by our genes. We are instinctively aware of what are the range of activities which we tend to be more skillful at and we are also aware of what are the range of activities which people close to us tend to be more skillful at. The good news is that we can significantly improve our three minds by means of experience and practice throughout the course of our life.

Learning to listen distinctively to the three minds constitutes an important tool of clarity. Each personal decision should be made taking into consideration the suggestions of all of the three modules. Each argument between two persons should be addressed undertaking separate reasonings for each of the three minds. Does it sound odd? When you learn to comforta-

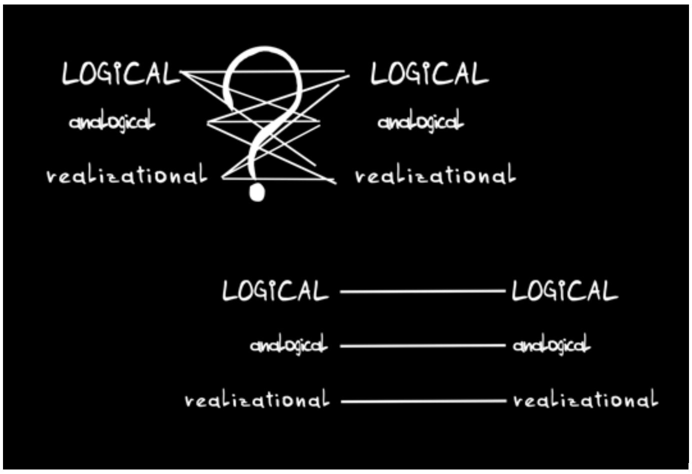

Fig. 2.2. The "6 minds" interrelating, confusion and clarity of the levels.

bly distinguish the modules you will realize that it is what always occurs in practice. The problem lies in the fact that only few are aware of that and thus it often happens to end up disputing unnecessarily only because the views of two different types of mind confront each other. In an argument between two people dealing with an important issue there are always six modules involved. One of the ambitions of this book is precisely to succeed in talking to all three minds. The fact that each of the three minds relies on a specific language is one of the fundamental elements that make the endeavour difficult. The language of the logical mind tends to be rigorous, formal and aseptic. The language of the analogical mind tends to be evocative, metaphorical and emotional. Finally, the language of the realizational mind tends to be practical, loaded with examples and somewhat passionate.

Many people just get bored quickly when they encounter an overly formal language...they would abandon us for good already at the third sentence. Some others frown upon an overly evocative language: their instinct leads them to look with suspicion at anything that is not precisely defined. Finally a considerable amount of people simply cannot hold on to the phase of theoretical explanation for too long if they do not rapidly see any practical applications.

You recognize yourselves in at least one of these three categories, don't you?

Of course, we who write are also like that. In particular, Antonella quickly becomes bored when faced with an excess of formalism, Gabriele immedeately gets irritated encountering unjustified emotionalism and we both cannot bear lines of argument that do not lead to anything concrete. The problem is that, as we already remarked in the first paragraph, we will deal with complex topics and often, we will examine them in an unusual manner with respect to everyday common sense. How should we proceed then? We will engage in the attempt to talk distinctively to all three minds. Moreover, we will try to repeat the same things in three different ways. Everyone will enjoy the freedom to navigate in the areas that are most familiar and pleasant, postponing the journey through the other zones to later times.

In the end, isn't semi-immortality a reason valid enough to make a little effort worth taking?

2.3 Gabriele Rossi

I was born in Milan on July 12, 1959. When I was a child I used to spend my birthday at the seaside, during the summer holidays. That day was marked by a personal ritual that not even my parents knew about. I have always loved the sea as well as boats. Obviously, at the age of eight the only "boat" I was able to autonomously sail was my trusty little dinghy with its good oars. I put it in the water and, on that particular day, rather than taking the usual inshore route towards the hilly and desert portion of the beach, I pushed myself out to the sea. To me it was an annual appointment that I was well determined not to miss throughout the period between my eighth and fourteenth years. The "game" with myself consisted in pushing myself further every year, in a sort of progressive challenge. At that age, the fundamental instinct is the pursuit of the limit, though fortunately mediated by the instinct of self-preservation. There was no reasoning, nor desire to show off (no one knew about it), nor prize. It was purely a pursuit of the limit that motivated the endeavour. I believe that for some persons it is a primary instinct just like hunger and sexuality. And I am convinced that it is a blessing as it allows those possessing it to live with ever-new objectives.

As an adolescent, I liked to reflect upon the meaning of life while walking in the meadows and the woods that surrounded our house in the countryside. I still don't know whether it is a normal activity for a boy aged fifteen years. I think it is. In particular because not only did I enjoy walking, reading books and playing chess, but I also liked girls and practiced several sports at a good level. One afternoon, as I was coming back to my room, one thought emerged clearly. With that ingenuity and emotional confusion which characterize adolescence, I told myself that I wouldn't be able to consider myself as a "real man" until I succeeded in understanding the true meaning of life. And in the meantime, I was watching, amused, Albert Einstein,'s chubby face pulling out his tongue on a sticker that I had just put on my desk lamp.

I like to think that the birth of the iLabs[2], our Research Laboratories on Immortality, dates back to the year 1977. I was eighteen years old and I was at my last year of school. It was in that same year that my union with Antonella got started and that I undertook my first systematic research on language and communication systems. Thenceforth each of my cognitive actions has mainly been directed towards the understanding of the Rules of the Game and each of my economic actions towards autonomously finding the funds necessary to be able to afford such endeavour myself. At the early age of 22, I already had a level of income that was just enviable for most persons.

I graduated from D.E.S. at the Università Bocconi with a final thesis focused on software industrialization[3]. Foolishly enough, I didn't bother to claim either my graduation certificate or the gold medal that was awarded to the best graduates of the academic year. Conveniently enough, it was my mother, with her usual practical sense, to take care of it. My main field of speciality has always been the software, and artificial intelligence in particular; nevertheless, over the years I have deepened the study, and achieved a good level in every subject I happened to stumble across. I have always felt that the path to the solution passes through the substantial understanding of the whole. For many years I've been working with Antonella on the modelling of the human mind. I think that we embody a fascinating, and hardly repeatable alchemy: she offered me the keys to those areas where I was weaker (and which therefore I would have never been able to investigate thoroughly by myself), I believe I have done just the same for her.

Unfortunately (or not, who knows?), it is not long since I became aware of the uniqueness of my own path. All along, I have lived a bit, so to say, detached from the context. I have always taken some activities for trivial when they were not trivial at all. When I managed to accomplish those things I had been patiently explained by others as impossible to realize I perceived their remarks as a useless waste of time. I have never lingered too long on the meaning of what occurred and, first and foremost, I have never concerned myself with providing any explanation of how I achieved such goals... it would have been nothing but another unendurable waste of time. I was probably wrong. If anyone reading this might happen to recognize herself, I would like her to know that today I value a higher intellectual availability as a more efficient option. Perhaps this will save her a few months of research.

I would fail to provide a complete overview of myself if I neglected to mention amusement. I believe people must determinedly search for joy and fun, of course without hurting either others or themselves. I think I have always carefully pursued enjoyment, certainly I was helped in this by having had the good fortune to encounter very soon a wonderful Game Mate. Honestly, I do not care whether we will suceed in making considerable steps further in the comprehension of the rules. Unfortunately, I am even less interested in convincing someone of something. I think this has been my main problem all along… I do not have any real associated emotions, what I have is just visions that I seek to interpret and implement.

2.4 Antonella Canonico

I was born at Gavirate on April 12, 1961. Why Gavirate and not Milan? Because I am the daughter of an unwed mother who lived in Milan, but decided to give birth away from prying eyes. My mother was a young girl, however, very much a girl and very little, or nothing like a mother. Beyond any doubt I was a difficult child, aggressive, restless, often violent. Nevertheless, I was a lover of the right and the true, good at school and therefore cuddled by all the teachers. In the period from my childhood until my marriage I have nearly always lived with my grandmother, a person of noble traits who was born into a very wealthy family, but reduced to poverty by the war and the poor investments of her husband. After secondary school, I attended art school but l did not complete my studies, in part because I started working at the age of sixteen and, in some measure, because in those years the art schools of Milan were a repository for violent, politicized extremists. A few years later, I resumed my studies and I graduated in psychology at the University of Ljubljana with a final thesis focused on overcoming the fear of death[4]. Why Ljubljana and not Milan? Because in Ljubljana I was able to enroll in a faculty very close to my mindset, an option that gave me the opportunity to take an education path which at that time was not available in Italy. To me life has been a great and incomparable school indeed.

For over 15 years I have been given a full-time commitment to the study of the relationships between mind and body, under a mainly therapeutic perspective. For a few years the central focus of my work has been the attempt to increase the probabilities of recovery for patients suffering from cancer. After addressing (and successfully solved) some particularly difficult cases, today I work with several oncologists who, probably without being able to come to a full understanding of what I do, send me those patients that they consider potentially receptive to my approach[5]. To be honest even I don't wholly understand what I do. I might say that I instinctively "know what I must do" and that, when I manage to establish the correct therapeutic relationship with the patient, it works. My domain of intervention might be defined as the reinstatement of the patient's self-referential balance. What is most stunning is that, regardless of the tumor type and the treatment protocol adopted, the patients I follow display significant improvements in their physiological parameters. Since I think that the presence of non-physical variables is not even conjecturable, for many years I've been searching with my husband for the so-called active ingredient.

Today, I believe I've come to possess a thorough knowledge of most facets of the human soul, both in terms of complexity as well as in terms of depth. Every day I engage myself in the study of mind, emotions and thoughts in their manifold scientific, philosophical and technological aspects. I also consider myself a strong woman who is able to tackle anything and who loves to fight alongside her patients trying to alleviate their suffering and pain. Many people assert that my way of reasoning is highly unusual. I have become aware of the fact that when I speak outside of the narrow confines of the therapeutic area, people often find it difficult to follow. It is both a fortune and a burden. It is a fortune since at times I succeed in identifying solutions that otherwise would be just beyond reach. And it is a burden because my paths, being them extremely unusual, are always very arduous. The most conspicuous consequence stemming from this situation is that the persons who live close to me have learnt to follow my hints, frequently resigning themselves not to fully comprehend the consistency of the underlying motivations. This most probably is a result of my mind being highly specialized in the analogical part. I have acquired the logical part essentially due to reasons of survival and the necessity of relating to the others. I think that the strength of my life and professional union with Gabriele precisely lies in our being complementary. What we have in common is a full-fledged realizational component, but we strongly diverge as far as the other two are concerned: he was born as a pure logical whereas, originally, I am a pure analogical.

The topics we examine in this book are extremely fascinating to me: this penetrating questioning of the whole universe of the mind, its references, its beliefs, its roots and its no-longer roots. I would like to undertake this major journey towards new life because I am not alone and I actively nourish the hope that a new form of thought might lead us to the immortality I will be able to share with my husband. I want to do it for my daughter, watching for her to grasp its benefits with her children and never leave them. If all that comes I will have fullfilled the end for which I am dedicated to research: being able to offer a new life to my patients.

2.5 The three phases

We deem it reasonable to conjecture that within some twenty years the advancement in the pool of technologies and knowledge related to genetics, nanotechnologies, artificial intelligence and psychoneurophysiology will lead to a substantial increase in both the duration and the quality of our life. In accordance with Raymond Kurzweil (the author of the book "The singularity is near"), we believe that a serious project aimed at semi-immortality might be composed of three distinct phases. The first phase consists in keeping ourselves as efficient as possible until the relevant technologies are realized. If we want to venture to advance an hypothesis of the temporal development of such phenomenon (here we are mostly driven by "symbolic" rather than scientific motives) we might indicate the year 2030 as the possible deadline of the first phase. Getting sufficiently healthy to the second stage should ensure a genuine opportunity to try to be semi-immortal. The second phase will be marked by the improvement of the technologies developed in the first phase up to the attainment of potential immortality itself. Again, taking a "marketing" perspective, we might expect the year 2060 to be the starting point of the third step. If these considerations are correct, the third phase will be so radically different from the present one that, for the time being, we are only able to outline a conjecture on some of the possible repercussions in the domain of values.

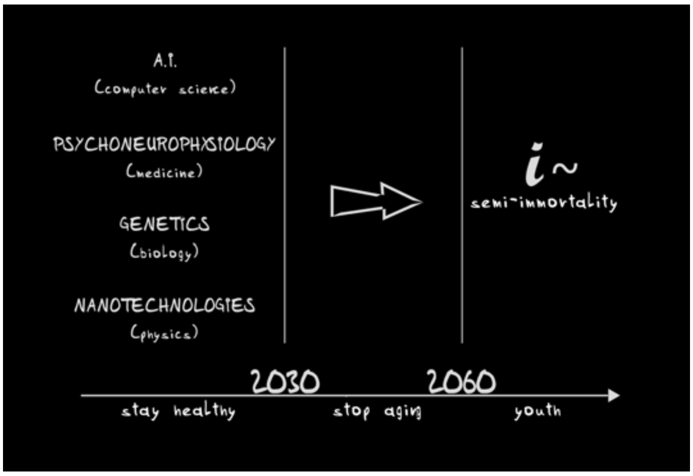

Fig. 2.3. The 3 phases towards semi-immortality.

We believe that a serious attempt to achieve immortality requires us to tackle the issue not only from a scientific point of view, but, necessarily, from a philosophical standpoint as well. So here is the sense of this book: science and philosophy of immortality, or more precisely, of semi-immortality.

At this point, many of our colleagues, friends and customers will be finally able to understand the bottom line of all our research and entrepreneurial activities whose cross-connections might result difficult to identify without this interpretation key. For instance, here is what the "i" preceding the name of nearly all of our products stands for. Sure, "i" as intelligence, "i" as Italy and, in the latest years, "i" as Internet… but all these have always been second-level meanings. The primary meaning of this "i" is "i as immortality".

2.6 Semi-immortality

Before we proceed any further, it is important to clarify and share the concept of semi-immortality. Why do we speak of semi-immortality rather than immortality? Because at the present time true immortality is a concept beyond our reach. When our universe comes to an end, and it is very likely to terminate at some point, any life form as we intend it today will cease to exist[6]. Nevertheless, for the time being, we can disregard this worry as, luckily, it belongs to a future so remote that we find it hard even to imagine. Therefore, semi-immortality may be conceived as an indefinite extension of life. We are not talking of prolonging a person's life up to two or three hundred years: we actually mean to make one live forever, thousands, perhaps million years. The mere act of writing this makes us shudder. But this is how things stand. From several perspectives we simply lack the logical categories to address such topic. We are just aware of a few plants as the only living organisms whose life certainly exceeds a thousand years, although a hoe or a power saw would be enough to put an end to their existence[7]. When we speak of semi-immortality we set our sight on achieving an accurate understanding of how our body (and our mind as well) works and on developing the adequate techniques aimed at enhancing it, preserving it in perfect efficiency and repairing it in the event of damages, regardless of the type of impairment involved. It is clear that our body may be subject to certain transformations and we may be witnessing a progressive integration of natural and artificial organs. Thanks to the expansion of our mental faculties, it is equally reasonable to expect an evolution of the concept of "I". However, the end result would not change: by virtue of the development of scientific research and its technological implications, at a certain point our life will undergo a potentially unlimited extension. When that time comes, many of our beliefs and values will require a substantial redefinition. In other words, we will approach the Solution to the Game.

Of course, it won't be easy as pie. Several forces will get in the way, not least human stupidity. If today murder is to be considered an unacceptable crime, in the future it will be a tragedy affecting humanity as a whole. Only a man will have the power to end another man's life. This is why this book is not limited to an exploration of science and technology, but it also addresses the issue of semi-immortality from a philosophical standpoint. If by means of scientific progress we are indeed approaching such goal at a fast pace, then it is equally true that we cannot help adjusting our philosophical view of the world as well. As it is always the case, technology per se is neither good nor bad, it all depends just on how it is employed.

As, on a daily basis, we read about the advancements of both the research and the respective applications in almost all the branches of science and technology, one thought emerges clearly: "wow, we are really getting close, there is not a long way to go!". A few months ago nanoscience enabled us to manipulate the atoms. It is to manipulate the atoms that we are talking about! Still a few months ago, we started to decipher the blueprint of any living form. That's the fundamental book of instructions! At the moment of writing, some people are trying to store information at the atomic level, other people are engaged in the attempt of modifying the DNA of some living forms. In our own small way, we are increasingly refining our understanding of how our mind processes thoughts and of the connections between mind and body. Other people have shown us that the second law of thermodynamics does not apply always and everywhere, that matter tends to self-organization at the elementary level and that the stem cells in our body have the ability to repair any organ, including brain and heart: "Wow, we are really close!" Consider, as an order of magnitude, about five thousand years of recorded history; no safe indications of the earlier periods are available to us, nonetheless we assume that the system man as we know it has been present on earth for roughly one million years. From the perspective of man, the next fifty years are but the blink of an eye. All of us who have the opportunity to take part in this moment must consider ourselves lucky. Too often, we forget and we allow ouselves to be distracted by trivial issues, both at a personal and social level. Too often, we allow ourselves to be misled by superstition, destructive emotions and the others' lack of attention towards us. Too often, in order to correct our mistakes, we lie, first to ourselves and then to others, thereby achieving the only result of accelerating our end. The bright side is that today we are attaining a precise comprehension of the reasons that lead us to behave so silly... perhaps the time has just come.

To assert that around the year 2060 man will achieve semi-immortality is undoubtedly a risky prediction which is, at least partially, influenced by subjective factors. We begin by expressing the firm conviction that semi-immortality will nevertheless be attained by man sooner or later and that, as far as we know, the spectacular acceleration in technological progress of the latest decades has enabled us for the first time in history to come up with a discussion based on scientific grounds. Several researchers' opinions converge to these premises and we believe that they can be easily shared by anyone with an interest in an accurate investigation of the subject[8]. From our point of view, the real point at issue is when all this will occur. Obviously, it is impossible to know the answer; what is feasible today is to formulate a resonable prediction of the crucial steps that will take us to that result, and we may call these as intermediate stages. As we have discussed, the crucial technological areas that will lead us to semi-immortality are basically four: artificial intelligence, psychoneurophysiology, genetics and nanotechnologies. For each of the four domains we try to identify with respect to today what can be considered as the symbolic mid-term step. In the field of artificial intelligence it is the passage of the Turing test[9] by a machine, namely the functional indistinguishability between a human and an artificial mind. In the sphere of psychoneurophysiology it is the employment of endogenous methodologies for the treatment of any kind of disease, i.e. the development of mind-body technologies, and their enhancement with the help of artificial organs enabling man to self-cure and preserving himself in perfect efficiency. In the realm of genetics, it is the thorough understanding of human genome, not only from the perspective of mapping, but also of its functional correspondents. Finally, as far as nanotechnologies are concerned, it is the possibility to insert nanorobots able to repair and reconstruct any type of organ into the human body.

The state of the art of the various disciplines can be expressed in terms of the completion percentage with respect to these objectives. Monitoring such percentage will allow us to give a sufficiently objective estimate of the time necessary to achieve the mid-term goal. On the basis of the information available to us, we expect, and all things considered, we hope that it will occur around the year 2030. Still adopting a marketing perspective, we may estimate that our current position represents about 15%-20% of the path. For all of the four disciplines such path began around the year 1950. Obviously, we put our trust in an esponential and nonlinear, progressive and uninterrupted technological trend. It might not be impossible...

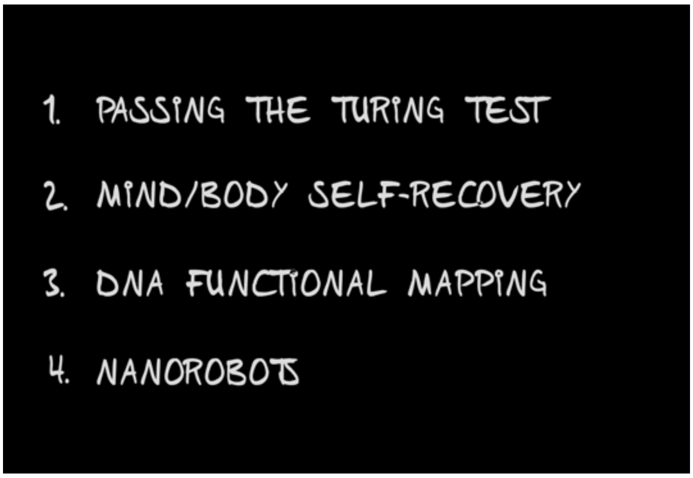

Fig. 2.4. The 4 mid-term goals.

2.7 Who is scared of immortality?

Of course, many people feel an instinctive fear of immortality. Through the study of the human mind, the reasons underlying all the various concerns can be regarded as fairly obvious. Let us begin from the scare of "violating nature". From our point of view, this is a well-founded fear and if, at any point in our path, we realized that the Solution to the Game was different from what we expect, we would immedeately interrupt our journey. Up to the present time, as we intensify the study of our universe and collect more information we strengthen our belief that the ultimate sense of our life precisely resides in the understanding of nature and in coming as close as possible to its rules. For the time being, we think that nature actually envisages our immortality and that it is precisely ignorance and the violation of its rules what leads us to death. Day after day.

The second fear stems from the concerns that the path towards immortality might not be suitable for all the human beings currently alive. Also this observation deserves the utmost respect. We might tell ourselves all sort of reassuring things, but, at the end of the day, we deem this concern well-grounded... age, health, intelligence, culture, beauty, strength, psychological profile... quite a pile of variables! We, who have been dealing with this issue for thirty years, still feel inadequate with respect to the path most of the time. Nevertheless, what can we possibly do? We think that in order to achieve semi-immortality the primary characteristic required is to be free from the anxiety of attaining it. If we are among those who will reach such goal, that's all the better, but, if we are not, then we are not.

The third apprehension regards how to reach semi-immortality in a good psycho-physical condition. One of the most frequent observations heard is precisely "what do I care about achieving semi-immortality at the age of ninety?". This we believe is a very intimate consideration and nothing can be said about it... we hold the firm belief that anyone must be entitled of the freedom of terminating his existence at the moment he deems most suitable. The voluntary Exit from the Game is an option that each one of us must be able to exercise should life become too painful a burden. However, we believe that such problem concerns only this transition period. A major development we envisage for the coming decades is a conclusive solution to the issues related to physical and psychic pain... now it is impossible to speculate on what the impact might be on the human minds liberated (or semi-liberated) from suffering and pain.

Finally, some see it as a potential form of selfishness towards future generations. Here we are referring to another well-founded fear of a society that might be even more static than the present one from the standpoint of demography both because of the bounded availability of resources and due to the sense of pampering that might derive from the indefinite extension of life. Our opinion is that in the coming years technological progress will be able to offer valid solutions to most of the problems related to the availability of resources. As far as future generations are concerned, we think that the universe is sufficiently vast as to contain a virtually unlimited number of semi-immortal life forms... we expect the Game to have foreseen also this.

2.8 This book

The ultimate goal of this book has been stated many times in the previous paragraphs and we will hold on reasserting it. Semi-immortality is within our reach, let us try to achieve it together. Therefore, this book is first and foremost aimed at those people who will somehow foster this process through their ideas and behaviours. That is to say, anyone. Regardless of its ultimate aim, we regard this book as a source of interesting innovations. We are also aware of the remarkable impact this book might have on everyday life, and, most of all, on that of the days yet to come. We have tried to take all posible steps to defuse all forms of extremism, emotionalism and excessive enthusiasm. Even running the risk of decreasing the probability of circulation of our ideas. We are not in any hurry.

This book, i.e. the ultimate synthesis of the work undertaken over the last three decades, represents a key to the interpretation of any facet of the reality surrounding us and of our mind. It aims at providing multi-level answers to any question man may ask. We believe that our approach has produced answers that are sufficiently coherent as to be presented in a systematic manner. Of course, we are not entirely sure of the exactness of our interpretative scheme, but we think it does not clash with any known manifestation of the real. We are not particularly fond of our ideas, and we stand ready to change our mind (wholly or in part) at the first clear contradiction with any verifiable and reproducible manifestation of the real. We hold no interest whatsoever in being right, we concern ourselves only with contributing, if possible, to the Solution to the Game. We are also aware that we have just outlined our interpretative key and that it will require continuous refinements.

One of our deepest beliefs is that, at the end of the day, we all tend to think and say the same things. To put it differently, we firmly believe that the differences are outnumbered by the similarities and that the closer we get to the Solution the sooner this will become plainly evident. It is very difficult that two persons of average intelligence and possessing the same information diverge in their way of thinking. When such a thing happens, the underlying motives are usually reasons of emotional nature or the need to assert one's individuality regardless of the opinion of the interlocutor. When emotions and what might be termed "intellectual narcisism" are stripped out from the reasoning, or at least if both factors are returned to their proper perspective, then it becomes very difficult for us to find interlocutors who think in a structurally different manner from our own. In fact, the initial dissimilarities are progressively reduced as the information and experiences are reciprocally aligned. This implies that, as it is the case for all complexly structured books, in our opinion, one reading is not enough to appreciate and understand our book in its essence.

Subsequent readings will allow to grasp the deepest correlations and meanings. It is only at that point that this book might hopefully be useful for the reader in terms of semi-immortality. The various sections, especially those concerning the philosophical part, will have to be taken into the everyday life and contrasted with personal experiences. For example, when we maintain that truth is the fundamental value to achieve semi-immortality, we would like it not to be received merely as some aseptic statement, but, on the contrary, we aspire it to be implemented and resoned out on a daily basis.

Consistently with what we said above, at the first reading, this book will not be much a "book of answers", but rather a "book of questions". If we have worked well we should be able to make something click in the reader's mind. Each will read and interpret it, obviously, on the basis of one's own degree of intelligence, culture and personal experiences. Skipping paragraphs and returning to them at later times does not imply any particular problem.

In our opinion, this book is more like a painting than a novel. A painting capable of triggering thoughts and feelings and, at the end of the route, of taking ourselves closer to semi-immortality. Just like all large paintings, it can be observed both from near and far, certain details slip through at first sight, some other emerge only after several observations. Most of the propositions contained in this book represent the tip of an iceberg, namely, the visible surface of many days, and, in some instances, many months of reflections and work. Of course, we cannot guarantee its actual usefulness, but we can testify the rigorous care we took in writing this book.

To continue the analogy with other forms of communication, this book can be experienced as a musical work as well: not all the pieces lend themselves to an immediate understanding, but after several listening sessions one may begin to discover a certain enjoyability and, most of all, a certain personal utility. We want to pause over these premises because this is precisely the spirit that has animated the project of this book. We are not interested in a quantative diffusion of this work (inasmuch as it was not conceived for an economic return and, even less, to gain some form of popularity), because we are rather strongly motivated by the search for travel companions who might help us to attain the Solution to the Game and who will therefore be able to share the prize of semi-immortality with us, or with our children.

At times we employ terms whose meaning might not be shared by all readers initially. Take for instance the term "game". We do not attach any unserious connotation to the word "game", quite the opposite. For us this word refers to a set of rules that must be understood and complied with. "Playing" means taking part to the game and "having fun" means being able to play successfully. "Playing" is the word of common use, whose meaning is the closest to what we identify as the prime cause of our existence. Obviously, there is no need for you all to agree with us right away: just give us some credit and follow us throughout the various sections of the book. Perhaps, in the end you will begin to employ this word embracing such meaning. A further example of a potentially ambiguous term is "technology". Many people think almost exclusively about machines, and in particular to, more or less useful, electronic equipment when they read the word "technology". Nevertheless, technology is much more than this. A process to produce energy, a treatment protocol or a system to make water potable, these are all forms of technology. Also the use of the terms "science" and "philosophy" might not be shared by everybody. As for us, technology is the prevailing expression of the realizational mind, science is the prevailing expression of the logical mind and philosophy is the prevailing expression of the anological mind. No aspect is privileged over the others, as all three are necessary and constitute the crucial tools we are given in order to strive for the Solution to the Game.

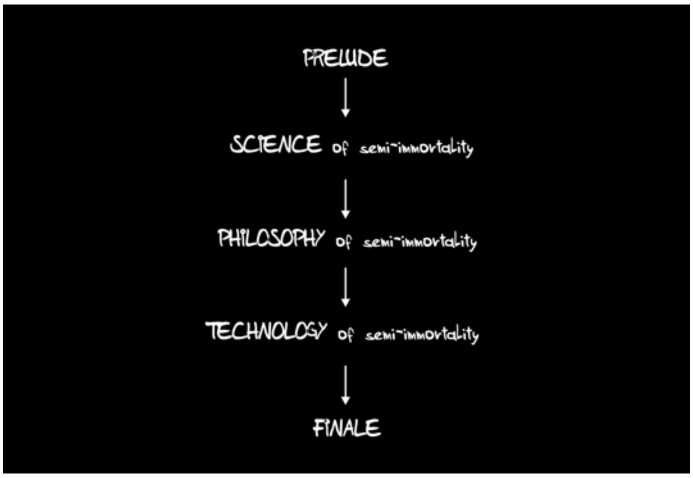

Fig. 2.5. The structure of the book.

Besides the *Prelude* and the *Finale*, the book is composed of three parts. The first part deals with semi-immortality from a scientific standpoint and it explores the physical and information worlds in a correlated manner. At the end of this section, the reader is expected to have improved his own understanding of the physical world, the human mind and the influences of mind on body. Through the filter of his own beliefs and experiences, the reader should also refine his ability to foresee the evolution of medicine and computer science in the coming years. Due to its very own nature, the structure of the scientific part cannot completely adhere to the traditional "premise, method, results, falsifiability" scheme that we are accustomed to. In fact, we venture into areas of the study of reality and the mind which at present are still very far from being falsifiable and hence demonstrable. Speaking in analogical terms, we may say that we are in a phase that might be compared to the first journeys to the New World. There is a new land to discover, we have seen it, we want to tell you about it, you should manage to detect it as well, perhaps we still don't know its exact extension, nevertheless it is there. The fruits of this land are allowing us and other adventurous explorers to progress towards the analytical comprehension of the functioning of the human mind, its relations with the body and its reproduction by means of the artificial intelligences. This particular new land would not be considerably more relevant with respect to all the other "new lands" man has discovered throughout the centuries, if it weren't for the fact that this, as we firmly believe, is the "land of immortality".

The second part treats semi-immortality from a philosophical point of view. Taking few initial hypotheses as our starting point, we will present our vision of the whole. The reader will be given the keys enabling him to formulate an answer to any question and then everyone will be abe to judge whether these responses are satisfactory or not. However, from our standpoint, such answers are precisely those currently with the highest probability of leading us closer to semi-immortality. At the end of this section, the reader is expected to have refined his understanding of the ethic, aesthetic and social values that are necessary to the achievement of semi-immortality. Our approach implies considerable repercussions on everyday life: accompanying us throughout the analysis of these consequences will be an enjoyable endeavour.

The third part gives a presentation of some of the projects that currently are the focus of the work in our research laboratory and that are intended as our small contribution to the practical attainment of semi-immortality. They will cover most of the areas investigated in the book, hence it should be possible for anyone to delve into the topics that hold one's interest most strongly. Those who are familiar with us know that "speaking" is good, but the most important thing is "doing".

2.9 The models of reference

We began writing this book when we catched a glimpse of the closure of the circle And such completion was realized with the emergence, albeit in a confused and difficult way, of what we deem to be the fundamental mechanism underlying the functioning of our mind and, more generally, of any living being's mind: the models of reference or, more accurately, "what we call models of reference".

The concept of model of reference is not easy to divulge. We have come to realize that most people grasp its general meaning immedeately, but the understanding in its essence becomes available only after several steps. This book often employs the concept of model of reference and thus it is appropriate to spend a few lines discussing it in a preliminary way in order to facilitate comprehension from the very first pages, although we are aware that a true understanding will only begin as the last chapters approach.

In the chapter headed "The mathematics of the models of reference" you will find a fairly rigorous definition, but an introduction of such concept only requires to conceive the models of reference as "any mechanism that, starting from stimuli, produces actions". Nothing in this notion seems particularly revolutionary, except for the fact that we consider this mechanism to stand at the basis of any of our perceptions, thoughts and actions. More generally, we believe that the models of reference are what underlie the functioning of any living being, besides being serious candidates for explaining how any manifestation of the real actually operates.

You are able to read these lines thanks to the models of reference activated within your minds. All things considered, we can understand each other because we share specific models of reference. By the same token, there are some aspects where we fail to achieve a perfect conformity in our mutual understanding since we are inevitably endowed with different models of reference. For example, if we did not share the model of reference of the English language, or, in case of translation, if someone did not put our models of reference into relation, then we would not be able to communicate by means of this book. Notwithstanding the comprehension of the text, if your eye weren't endowed with specific models of reference, you wouldn't be able to read these lines, perhaps, you would manage to "see" them, but not to read them. If you possessed different particular models of reference (perhaps exclusively specialized in infrared vision) you couldn't even see the book in your hands.

The concept of model of reference is present at any level of analysis chosen, from the macro model of the English language, to the micro model of the black dot on the letter "i". By means of the automatic and progressive activation of specific and identifiable models of reference, a frog moves its tongue to catch a fly in front of it and you have chosen what to wear this morning.

We are phobic because our mind triggers a "wrong" series of models of reference, we develop tumors when our cells activate "erroneous" models of reference. Therefore, it is possible to treat phobias, as well as tumors, by intervening on the activation of the models of reference. We vote, or we do not vote, a given political party on the grounds of a subsequent series of models of reference. We feel fear, pleasure, sadness or joy depending on the models of reference being propelled. What is it that enables a chick to come out of its shell? What is it that pushes a person blinded by hatred to the point of killing? What is it that allows our body to digest and absorb the nutrients of a pizza? It is always and only the activation of some well-defined models of reference.

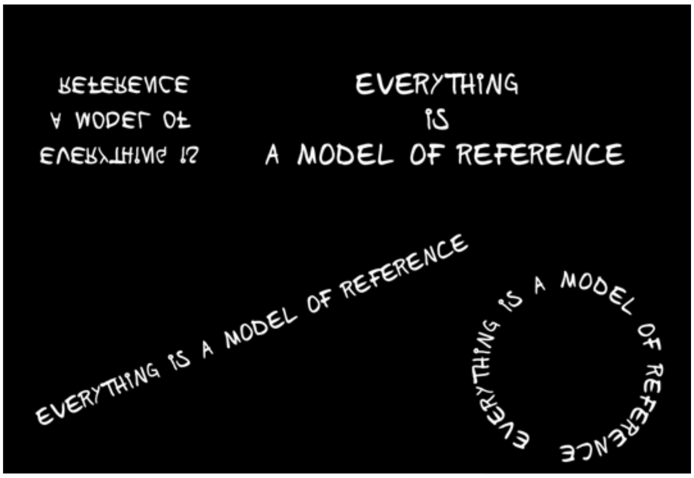

Fig. 2.6. Everything is model of reference.

The models of reference can be applied to anything, even abstract concepts. What is an algebraic operation if not the successive employment of a series of well-identifiable models of reference? What is a management software? What is a mathematical theorem? The realm of the logical mind is where the models of reference find their natural and historical evolution. Nevertheless ,in our opinion, it is in the spheres of the analogical mind and of the realizational mind that they represent a remarkable conceptual and, most of all, computational leap.

Well, now we are ready to take the first steps.

[1] Research and related literature concerning the possibility of indefinitely extend human life span have registered an exponential increase in recent years. What until a few years ago was looked at as an idea put forward by a few visionaries is now emerging as a real possibility. Here follows a brief list of twenty scientists who, in our opinion, stand out as the most prominent among those scholars who deal with this subject on a daily basis and who substantially share our idea on semi-immortality being within reach; four of them are also included in the list of the "100 great players".
Allhoff Fritz, "Nanoethics and Human Enhancement", *Nanotechnology Perceptions*, 2006:2
Bainbridge William Sims, *God from the Machine*
Benecke Mark, *The Dream of Eternal Life*
Bostrom Nick, "A History of Transhumanist Thought", *Journal of Evolution and Technology*, 2005:14
Chorost Michael, *Rebuilt*
de Grey Aubrey, *Ending Aging*
de Magalhaes Joao Pedro, "The Dream of Elixir Vitae", *The Scientific Conquest of Death*
Drexler Eric, *Engines of Creation*
Freitas Robert, *Nanomedicine*
Goldstein Alan, *Nature Vs Nanoengineering*
Goertzel Ben, "Creating a Positive Transcension", *Dynamical Psychology*, 2004a
Grossman Terry, *The Baby Boomers' Guide to Living Forever*
Hughes James, *Citizen Cyborg*
Kurzweil Raymond , *The Age of Intelligent Machines*
Lin Patrick, "Nanoethics and Human Enhancement", *Nanotechnology Perceptions*, 2006:2
McCarthy John, *Formalizing Common Sense*
Minsky Marvin, *The Society of Mind*
Rose Michael, *Can Human Aging Be Postponed?*
West Michael, *The Immortal Cell*
Wowk Brian, *Cryonics Reaching for Tomorrow*

[2] iLabs, brief summary of the main acttvities:
1977. Researches in the field of language and aesthetics.
1978. Development of mathematical software for electronic calculators.

1979. Planning of advertising campaigns. Conduct of motivational analyses.
1980. Creation of tools to study the processes of decision-making and expectation formation. Business-oriented application of the new personal computer technology. Development of instruments in the domain of data compression.
1981. Construction of the first Italian telecommunication network based on PC technology (connecting 25 cities). Development of tools in the field of financial forecast and analysis.
1982. Realization of the first European integrated information system exclusively based on PC technology (primary distribution company).
1983. Development of tools to study the operation of creative thinking. Simulations in the field of artificial life forms. Creation of tools in the sphere of robotics and visual recognition. Realization of *Systema I*, the first Italian relational database.
1984. Construction of one of the first examples of a self-modifying application program(forecasting model for the production planning of a leading food company).
1985. Realization of an expert system for financial flow management. Development of tools in the field of computer graphics.
1986. Installation of the first *IAssicur* information system aimed at the insurance sector. Experimental researches on the psychology of fashion..
1987. Construction of the *Icrypto* cryptographic system.
1988. Development of tools for multimedia and voice recognition technology.
1989. Creation of *I3Net*, a software that enables the centralized management of all communication processes. Development of tools in the field of process control and domotics. Experimental studies in the area of psychology of taste.
1990. Creation of "il Giornale del Broker", one of the first examples of a fax-journal. Realization of pictures through the *Cyber-I-Arte*.
1991. Construction of one of the first world examples of an expert fax system: *IAssist*. Birth of the *Cyber-I-Musica*. Development of tools in the field of mental storage and classification.
1992. Opening of *I-TecnoVita*, a creative show room in central Milan, where the web Internet phenomenon is anticipated and forecast. Realization of econometric models for management control. First major results in the field of clinical psychology. Birth of the *Cyber-I-Letteratura*. Creation of a representation model of the human mind.
1993. Installation of the first functioning expert systems in the insurance domain: ‘ *i5* ’.

1994. Development of tools for virtual reality applications in the economic and social spheres. Construction of the BBS *Cyber-I-Spazio Assicurativo.* Design of virtual cities. Introduction of the service enabling the real-time comparison of the car insurance prices charged by all the major companies.
1995. Realization of *ZaZen*, an expert system for real-time trading on derivative markets. Setting up the first insurance policies that can be purchased online. Birth of a version of the symbolic mnenmonic system called ‘ *i6* ’. Activation of the first prototype of “Virtual Entity” able to answer to any question formulated in current Italian.
1996. Initiation of the European project *Regis* (Re-engineering of the Insurance Services). Researches focused on the employment of the Virtual Entities in the field of clinical psychology. Birth of *IAssicur97*, one of the first intranet/HTML-based mangement softwares worldwide. Launch of a web section devoted to psychological assistance..
1997. Installation of completely Internet-based management iinformation systems. Creation of a web Virtual Entity specialized in the insurance sector. Development of tools in the field of hypnosis and Neuro-Linguistic Programming.
1998. Birth of “Cyan”, one of the first online newspapers, devoted to financial and insurance markets. Experimental researches in the field of psychology of enjoyment.
1999. Birth of *IComp2000* to issue insurance policies at the bank counter. Development of tools in the domain of biofeedback.
2000. Birth of *IAssicur Next 2000* through the adjustment of the database to make it compliant with SQL standards. Remarkable results in the study of recursive self-reference and its applications in the medical/psychological field. Experimental studies concerning the economy of developing countries. First researches in oncology.
2001. Birth of *IAssicur.Net*, one of the first word examples of a complete management software available online. Development of computational tools in the field of dynamic complex systems. Experimental researches in psychology of risk. Development of 3D/VRML interfaces.
2002. Opening of “Buddhamam”, a 1000 mq wellness center on the outskirts of Milan. Researches in the domain of roboethics.
2003. Release of *Sdk Advanced* for *IAssicur*, the factory of insurance policies. Activation of *PaginaCliente*, a real-time monitoring system for the customer assistance activities. Development of tools in the field of automatic learning and

context comprehension. Theoretical reseraches in basic physics. Applications of the self-referential approach to the treatment of some genetic diseases and of the immune system.
2004. First WebTV interactive applications with multicast technology. Launch of *IWTester*, an automatic testing program for software production. Development of tools in the domain of semantic-based search engines.
2005. Release of the versions of the database *IAssicur SQL Grid* and *Load Balancing*. Development of computational tools based on the mathematics of the models of reference. Experimental studies in the field of psychology of emotions.
2006. Release of the Transactional version of *IAssicur*. Studies in the field of genetics and the inheritance of acquired characteristics. Implementation of the *AJAX* technology in the management sphere. First researches in the area of cardiovascular diseases.
2007. Researches in the field of nanotechnologies and molecular computers. Release of the *Large DataBase* version of *IAssicur*. Publishing of "Semi-Immortality": science, philosophy and technology for the indefinite extension of human life.

[3] "The Omega System. A proposal for software industrialization". Università Commerciale Luigi Bocconi – Academic year 1984/1985.

[4] "To die without fear. Death in our culture and two proposals to face it". University of Ljubljana – Department of Psychology – Academic year 1995/1996.

[5] After a few years marked by the mistrust on the part of some physicians still linked to the old therapeutic approach, today the situation has improved as psychological suport in the treatment of cancer patients is fairly widespread. This allows us to calmly and fruitfully work for the patient, in collaboration with several hospital facilities; in particular, we like to mention thel San Gerardo hospital of Monza and the Policlinico hospital of Milan.

[6] It is extremely complex to establish the fate of our universe with reasonable certainty. Relying on current cosmological knowledge and assumptions consistent with Albert Einstein's theories, we may hypothesize that a substantial part of such fate depends on the relation between the current baryon density

and the critical density, the latter being a function of the Hubble constant and the universal gravitational constant. In the case of low matter density, the universe would be undergoing an infinite expansion, but, in the long run, this would lead to such a drop in temperature as to make life as it is currently conceived extremely arduous. Conversely, a situation of considerable density would cause a significant decelaration thereby ultimately leading to the collapse of the universe in a sort of singularity which may then result in a new Big Bang (oscillating universe theory). In this case, in accordance with the Big Bang theory, this would lead to a universe dominated by radiation rather than matter and again to conditions incompatible with life.

[7] There exist some *Welwitschia Mirabilis* in the desert of Namibia, some Sequoias in California, a few Baobabs in Malawi and a few Ginkgo Bilobas in the Taixing area of China which almost certainly have more than two thousand years.

[8] *The coming Singularity.* In order for the concept of technological singularity to be found for the first time, we have to go back to at the Fifties and the Sixties to look at the discussions and reflections of several scientists such as John von Neumann, Stanislaw Ulam and Irving Good. Nevertheless, the birth of the concept of technological singularity as we understand it today must be ascribed to Vernor Vinge and, in particular, to his intervention during a NASA symposium in March 1993. As far as semi-immortality is concerned, a certain number of researchers maintain that it cannot be achieved inasmuch as the coming singularity will be characterized by insurmountable intrinsic limitations; the two most famous proponents of this "restrictive" view are probably the physicist Roger Penrose and the philosopher John Searle. However, Vinge proposes a diametrically opposed scenario: he forecasts that the coming singularity will be so limitless that, at a certain point, machines might render man obsolete. And, at such point, the only option to manage this transition will be to englobe the technological evolutions into a new post-human race. Without coming to the extreme conclusions of some dangerous fanatics numerous scientists are concerned about overcoming the limitations of the coming singularity. Outstanding among them is Bill Joy, a leading entrepreneur in the IT sector, as well as one of the fathers of the Java programming language and the author of a famous article published on *Wired* magazine in April 2000 whose title is "Why the future doesn't need us". Despite the pessimistic forecasts of some research-

ers, at this very moment, many people are working just like us with substantial investments of time and money to make semi-immortality attainable in the coming decades.

[9] *The Turing Test* . As it is well known, there are a lot of Internet sites devoted to betting, some of which are marked by a taste for intellectual provocation as well as for the game per se. One of the most popular sites is *LongBets* and one of the most interesting bets made on this site is that between Raymond Kurzweil and Mitchell Kapor. Kurzweil has bet Kapor 10.000 dollars that a machine will pass the Turing Test by the year 2029. Since they were born around the year 1950, both are likely to be still alive at the time the bet will have to be paid off... especially if Ray is right! When Turing completed his theoretical work on the Universal Mahine, he was well aware that it covered only a limited area of the human faculties, namely that of "mechanical" calculation skills. In 1939, he began to tackle the further steps focusing himself on the analysis of higher faculties such as intuition and creativity. Together with Norbert Wiener, Turing must be numbered among the first advocates of the so-called "strong artificial intelligence", i.e. the possibility that, at some point in the future, machines will be endowed with mental capacities comparable to those of human beings. Not surprisingly, in the Forties and Fifties such stand was not warmly welcomed by the scientific community and this fact significantly contributed to further isolate the scientist from the normal social context (even today, this concept of substantial "man-machine" equality remains a big taboo, not only among the population at large, but also among numerous computer scientists. With respect to this "philosophical" dispute, Turing, tired of endless discussions about what qualifies to be considered "human" and what does not, proposed a simple test to settle the issue. "We may conclude – Turing argues – that a Machine will possess the same mental faculties of a Man when a person of average intelligence and education, if involved in a conversation via a monitor and a computer, is unable to distinguish a Machine from a Man". Turing merely refers to monitor and keyboard because at the time of his proposal, speech synthesis and speech recognition were just a mirage. If we were to put it into a more familiar laguage, it would go somewhat as follows: "if, while chatting on the Internet with someone we don't know, we weren't able to distinguish a software from a human being, then this software would pass the Turing test".

SCIENCE OF SEMI-IMMORTALITY

3. The Physical Universe

In this chapter we will expose our model of physical universe. It might be useful to remark that there are several theories akin to the approach we take in modelling reality. All these theories share the underlying assumption that universe is discrete and non-continuous, namely, that there exists a minimum unit of space which is not divisible to infinity[10]. Besides Albert Einstein, also Erwin Schroedinger (one of the founding fathers of quantum physics) advocated a shift to some form of spatial granularity. Modern twistor theory[11] itself draws its origins from Roger Penrose' s spin network theory. We think that modelling the universe taking a discrete view allows to make the understanding of the real much easier and it is a useful support to come closer to comprehend the rules of the game. If our "everything-works-the-same-way" hypothesis is correct, then understanding the functioning of the physical world will also foster our comprehension of how the mind operates. Also because we expect information and matter to be but two different, yet equivalent, ways to represent the same thing.

There are a couple of aspects that are to be taken into account by anyone dealing with considerations of cosmological nature. The first element to consider is that we are proceeding at a pace which is counter-intuitive to our senses. Not only do we know that the Earth rotates on itself and orbits around the Sun, but we also know that, with respect to any other point in the Universe, we are moving at such a high velocity that the other two aforementioned movements become marginal (although they nevertheless remain significant in relation to the speed we are familiar with). It is extremely difficult to come up with the exact figures since we lack a univocal reference point; nevertheless, we are fairly sure of the minimum value of this velocity which is at least 240 km per second (per second!)[12]. It is relatively far from the speed of light (about 300.000 Km per second), but still a considerable speed. We apply this concept to our spatially discrete lattice universe (any other representation would be equally acceptable): regardless of the direction we choose to consider, the movement of the cell would appear to be a phenomenon characterizing the dynamic of the events in a significant manner.

The second point regards the opposite side, namely the very small. It should be borne in mind that a substantial portion of what we know about atomic physics and practically our whole knowledge of subatomic physics rely on conjectures not directly observable[13]. No one has ever seen an electron, much less a quark. The instruments available today allow us to measure their effects, but not yet to observe them. This is the bad news. The good news is that the development of nanotechnologies in the coming years will enable us to get closer and closer to the direct observation (and the manipulation) of the matter, first, at the atomic level, then at the sub-atomic one. Our view is that the path towards the thorough understanding of reality must pass through a further granularity of space-time and not through an increase in the sizes to consider (an approach taken by the superstring theory, for example). Of course, we stand ready to revise our thinking and to adjust our fundamental assumption in its entirety should new evidence emerge.

We will investigate, in terms of resolution, how our senses are capable of perceiving the reality surrounding us in the chapter devoted to the mechanisms of learning. If we examine the same concept from a dimensional point of view, taking the meter as the basic unit of measure of our reality, we can assert that our eyes can perceive objects of a size of around a tenth of a millimeter (10^{-4}) and this threshold may only be overcome

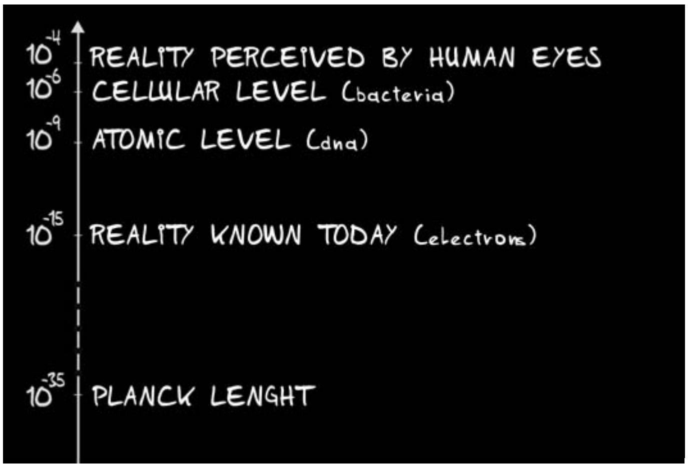

Fig. 3.1. Some dimensional levels of physical reality fisica (uo.m. 1 meter).

by means of machines. Keep in mind that the order of magnitude for bacteria is one hundred times smaller (10^{-6}) and that, for the time being, the highest detail level we might be able to observe is the atomic-molecular one (10^{-9}), that is ten thousand times smaller than the minimum level accessible to the human mind. As far as all the rest is concerned, only conjectures and indirect observation are available. In order to reach the dimension of electrons (10^{-15}) we must take a further leap down in size by a factor of one million, and therefore of one hundred billion with respect to "our" tenth of a millimeter. However, we are still very far from what might be considered as our elementary cell. On the basis of the present knowledge, we must move further to the level of 10^{-35} to reach the true limit of the size of the elementary cell in our discrete universe and, consistently with Max Planck's theoretical framework, fix the minimum unit of time in the order of 10^{-44} seconds[14]. Such units of measure are not only completely beyond the reach of our senses, but they are also difficult to be grasped by our intellect. Hence, the road to complete the Solution to the Game is still very long and we hope that the exhaustive understanding (and the resulting manipulation) of the atomic dimension will be the ticket to the achievement of semi-immortality.

3.1 Modelling physical reality

What we are going to expose below is the model of the universe we have developed. We want to stress that it is a purely speculative model that will serve as a basis for subsequent steps. Based on the information we have, it is not in contradiction with any of the currently known laws of physics, nevertheless, the sole purpose of this model is to offer a possibly useful tool for the interpretation of reality. Furthermore, our model has the advantage of simplicity over all other models, even though, again, we make no claim to be right about our view. Since formal rigour provides us with a useful tool for reasoning, we have deemed it convenient to start from building formally sound foundations upon which we would construct all the subsequent hypotheses, both from the point of view of the definitions employed, and from the standpoint of the descriptions of its functioning.

First, as aforementioned, we consider space as discrete and non-continuous, i.e. composed of a cluster of minuscule, indivisible elementary cells. Analogously, we assume time to be discrete, that is, formed of a sequence of successive moments. We hold each elementary cell as capable of assuming different states. Again, we deem these states to be discrete. Finally, there exist a few rules governing the change of state of the cells. Therefore, at time "t" the universe will be composed of the set of all the cells, each characterized by a given state. The application of the rules to the states of all the cells will determine the universe at time "t+1". Before the actual realization of the universe at time "t+1" occurs, we will have a "potential t+1" time where all the states are computed and possible conflicts are solved. If we move back to higher dimensional levels, an example of potential conflict might be the impossibility for two particles to occupy the same space at the same time.

We are done with the basic introduction to our universe. Everything else follows from these simple elements. The complexity before our eyes would be nothing but a more or less stratified consequence of this setting. One of the most striking implications of such framework is the fact that movement would not exist per se, but it would rather be a change of state of the cells, which we interpret as movement. Nothing moves, nothing expands or shrinks, it is just the cells that change state.

To sum up: given a discrete finite class of space **S** composed of ***s*** possible positions, given a discrete class of time **T** formed of ***t*** possible moments, given a discrete finite class of states **Q** comprising ***q*** possible states per position, given a discrete finite class of rules **R** constituted of ***r*** possible rules governing the change of states contingent on position and time, we define our universe **m** composed of the classes S, T, Q and R.

3.2 The class of space S

Let us amuse ourselves by formulating a few hypotheses concerning the nature of the elementary cells. Let us start from assuming that the space of the universe can be wholly filled. This is far from obvious, also because it would be very difficult for us (who live in it) to detect the presence of any non-occupiable spaces. In a two-dimensional space, only three regular shapes would be available to undertake the uninterrupted partitioning of space: equilateral triangle, square, hexagon. The proof of the pudding is in the eating. Analogously, in a three-dimensional space, only three regular shapes would be available to undertake the uninterrupted partitioning of

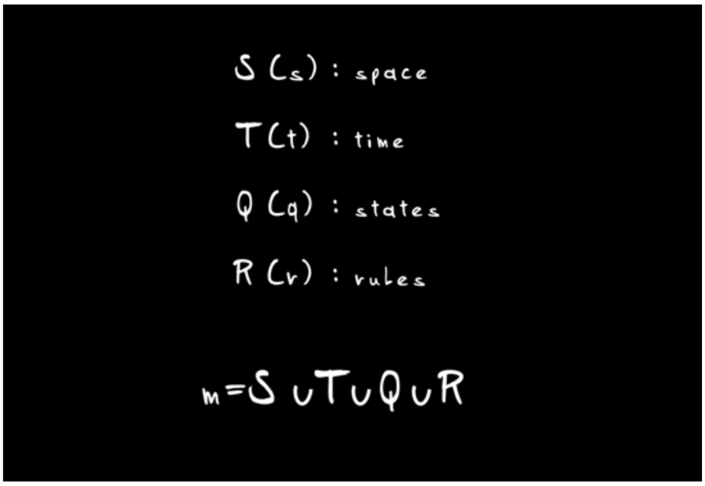

Fig. 3.2. Our model of physical universe.

space: regular tetrahedron, cube and rhombic dodecahedron. Even granting that our universe had actually three spatial dimensions, we must confess our marked preference for the rhombic dodecahedron. Numerous computer simulations led us to advocate this hypothesis inasmuch as it is the one that performs best in explaining apparent movement. It is not straightforward at all to conceive it in terms of three-dimensional cells, whereas it is fairly intuitive in terms of two-dimensional cells.

The two-dimensional equivalent of the dodecahedron is the hexagon. The space occupied by hexagons has several significant advantages over a space occupied by squares. First, the distance between cells can be easily approximated in terms of radius. Around each cell, there are other six cells which are all placed at the same distance. At distance "2" there are always six cells with the same angle of escape and the same distance separating them. And so on. Of particular interest is the aggregate composed of six contiguous hexagons arranged in a circu-

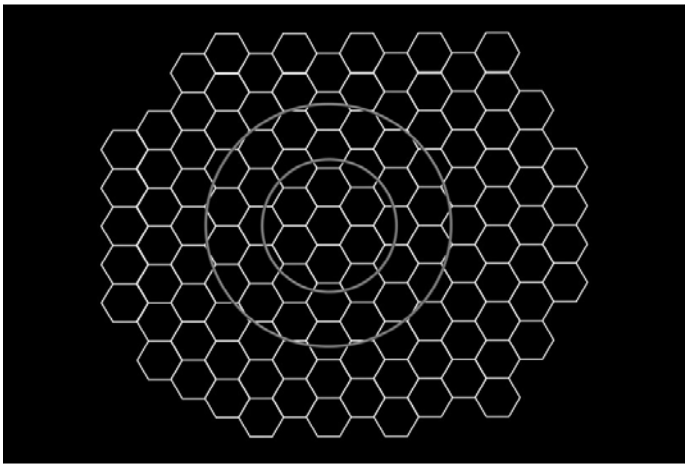

Fig. 3.3. Hexagonal elementary cells in a two-dimensional space.

lar form. Specifically, if we consider its three-dimensional equivalent, we obtain the approximation of a sphere (formed of twelve dodecahedra). Taking this solid as the basis of our universe allows us the convenience of being able to move practically in every direction and of computing distances in a finite manner. Computing in a finite manner implies rejecting that there exist in reality the perfect circle and the perfect square. However, if we assume the cell to be sufficiently small, we expect to obtain approximations that are compatible with all the known mathematical functions. A few months after taking a liking to this geometrical shape, we happened to reread Plato's Timaeus[15], where, referring to a figure very similar to the rhombic dodecahedron, he defines it as the geometric figure "... the god used to decorate the universe...". At the very least, we can say we are in good company!

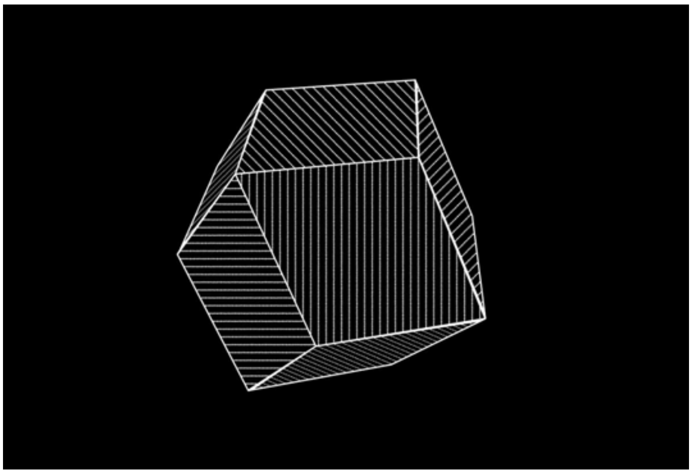

Fig. 3.4. The rhombic dodecahedron.

3.3 The class of time T

We can conjecture a discrete class of time T formed by the succession of the events t1, t2, t3, etc… interspersed with a moment of transition at which the universe computes its potential before realizing it. Therefore, we will have:

t1 => computation of potential => t2 => computation of potential => t3 …

This framework has some intriguing implications. First of all, the duration of the instant "t1" might be different from that of the instant "t2" if the time required to compute the potential were different. The nice thing is that we probably wouldn't even realize it inasmuch as our life is marked by the cadence of manifest instants and not of potential ones. If we considered the realization of the computation of the potential as external with respect tto our universe, we would expect a virtually unlimited processing capability. Conversely, if it were internal, we would expect some dependence upon the conditions of the surrounding space. In the former case, we would have a sort of absolute time, whereas in the latter one we would have a sort of relative time that might be subject to the influence of the surrounding space. In the context of external elaboration, it would make sense to speak of "uniform absolute" time and therefore of actual simultaneity of the events, although we would perceive some local distortions. Vice versa, in the case of local processing the actual simultaneity of the events could not be guaranteed.

3.4 The class of states Q and the class of rules R

We believe it is reasonable to define the universe as the set of space, time, states and rules, just as it is reasonable to assume that the universe is discrete: we won't go as far as to assert that this is how things really stand, but we only maintain that these assumptions are not glaringly impossible. Conjecturing the presence of a potential moment preceding the realization of the manifest moment does not constitute, per se, a theoretical novelty. Just as there is no newness in the hypothesis of the non-existence of actual movement. Somewhat more irreverent is the hypothesis that the universe may be composed of rhombic-dodecahedron-shaped cells. However, if we assume the universe to be discrete and spatially three-dimensional, then the breadth of possibilities of efficiently occupying it is rather narrow. Even though, from René Descartes onwards, the cube has enjoyed more favour, we think that the rhombic dodecahedron appears to be a better candidate for the role of elementary cell of the universe. The difficult (truly difficult) part comes when we begin to discuss states and functions. From a theoretical point of view, we envisage a limited number of states, perhaps three (i.e. neutral, positive and negative). We also believe the fundamental rules to be extremely restricted in number. Furthermore, for reasons of computational efficiency, we would expect the fundamental rules to be connected around the perimeter of the same cell. To put it differently, the state of the single cell should exclusively depend on the state of the twelve neighbouring cells (in the case of dodecahedron). How space and time are actually structured and, most importantly, identifying the relevant states and functions go beyond the purpose of this book. The crucial point lies in the hypothesis that these four concepts suffice to explain virtually all of the manifestations of the real and, most of all, that they may serve as underlying foundation for any of our subsequent definitions and descriptions.

By comparing our simulations with the theoretical results attained by the theory of relativity, quantum mechanics and the standard model of particle physics, we have come to the conviction that the discrete (or "granular", as Albert Einstein defined it) universe hypothesis is truly plausible. The hypothesis of discrete time in a discrete space is consonant with the concept of maximum reachable velocity[16] that, as we know from the theory of relativity, would appear to be the speed of light. We recall that, according to our assumptions, in the universe there does not exist real movement, but only apparent movement which results from the change of state of the single cells. Under such perspective, the maximum (apparent) velocity would be determined by the change of state of a contiguous cell from a time "t" and a time "t+1".

The hypothesis of the potential time at which conflicts are solved tallies well with the probabilistic view of quantum mechanics[17]. However, also in this case, in accordance with Albert Einstein's position, we consider the seemingly random events as nothing but deterministic behaviours that we perceive as probabilistic due to the implementation of a function of conflict resolution, perhaps even endowed with memory. Whatever the states and functions of the manifest world, we have come to realize that, in order to avoid any distortions or privileged directions, it is useful to resolve conflicts in a non-univocal manner, namely by applying their own functions of resolution in an equally probable way. Finally, the hypothesis of the rhombic-dodecahedron-shaped elemantary cells fits well with the electron's zig-zag behaviour predicted by the standard model of particle physics[18], such behaviour can be obtained, for instance, and perhaps less elegantly, by means of an hypothesis of universe composed of cube-shaped cells.

On the grounds of the concepts of class of space and class of time we have just laid out, we carried out a considerable number of computer simulations of universes characterized by different classes of state and different classes of rules. We must immediately say that the attainment of a satisfactory solution is well beyond the horizon. Probably, achieving such a solution would mean approaching the understanding of how our universe is made. Playing with different combinations of states and rules led us to develop the conviction that states and rules are strictly correlated and can be regarded as the quality of the universe. Of particular interest, in a two-dimensional universe, was a simulation based on a state vector composed of three values (-1, 0 e 1), three operators (=, NOT e AND) and seven directions (one for each side of the hexagon plus the null direction). The result was to obtain a binary universe similar to that of electronic calculators[19].

Therefore, the following conviction emerged: regardless of what the state-classes and function-classes of our universe truly are, speaking of "quality" equals speaking of "information". Stating that everything is physical (hardware) or maintaining that everything is thought (software) are two equivalent assertions that give a description of reality from two different angles. The former describes it from the standpoint of the states

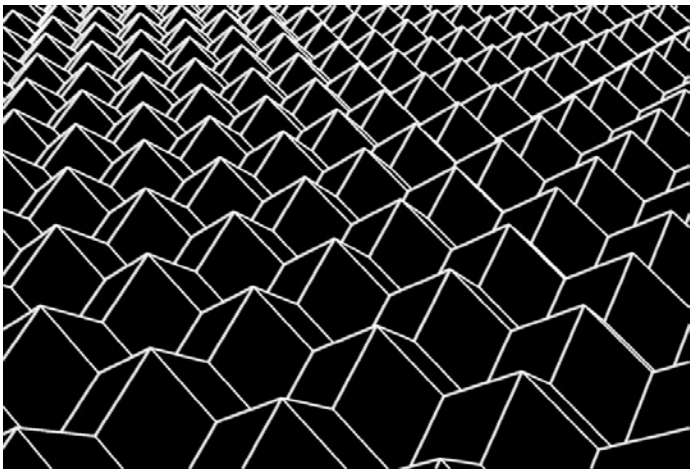

Fig. 3.5. Section of a space composed of rhombic dodecahedrons.

of the matter, while the latter does so from the point of view of the information contents. We are not far from neutral monism[20] and the researches of many scientists dealing with bits and atoms, for instance Konrad Zuse (the first ever to realize, in the year 1941, a working digital computer). We envisage that a modification in the physical state of the matter will have a specific correspondence with a modification in the information [21]. And vice versa!

In the following two paragraphs we will outline the state of the art of the two disciplines that are focused on the attempt to manipulate the matter at atomic-molecular level, inasmuch as we consider this particular step as a crucial one in the path towards semi-immortality. Nanosciences deal with manipulation at physical level, while genetics is concerned with manipulation at biological level.

3.5 Nanosciences

It is fairly safe to affirm that the birth of nanosciences was marked by Richard Feynman's well-known speech at the annual meeting of the American Physical Society on December 29, 1959 at the *California Institute of Tecnology*[22]. Today his discourse still maintains its challenging and inspiring nature: this speech foretold the possibility to manipulate the individual atoms emphasizing the potentialities that this would imply in the domain of computer science, moreover, it anticipated some of the most critical technical obstacles we actually met in the process of developing such technology. Feynman's prophecy has remained in the realm of possibilities until the invention of the scanning tunneling microscope that was developed in the period between 1983 and 1989 and enabled us to "see" the single atoms on the surface of materials. In 1986 Eric Drexler published "Engines of Creation" thereby opening the way for the first practical applications of nanosciences. About twenty years later, nanotechnologies are employed in several commercial products[23] but have contributed only marginally to the two areas where they will be indispensable for semi-immortality: computer science and medicine.

The manipulation of the matter at atomic-molecular level brings about a series of spectacular opportunities in all the fields of human sciences and technologies. The consequences of their development are not even remotely predictable in all their various implications. Nevertheless, we can forecast with certainty that they will be employed to build computers endowed with computing capabilities that outstrip those of present computers by several orders of magnitude and to construct nanorobots that might be inserted in the human body to act as a support to our immune system and our ability to regenerate damaged or defective organs. A small army of properly instructed nanorobots will easily be able to eliminate all forms of cancer and infection, to remove arterosclerotic plaques, to prevent strokes and heart attacks. That is to say, to eliminate more than seventy percent of the current causes of death. At this point, we will gain on average several tens of years of life (which certainly is not bad), but we will not be able to speak of semi-immortality yet, since the problem will move to the degeneration of tissues and vital functions, in particular those of the brain and, more generally, of the nervous system. Furthermore, we expect nanotechnologies to provide us with a crucial contribution to understand the functioning of the various types of cells and, at a later stage, they will constitute the main tool for sustaining and regenerating them. And it will be precisely at that moment that, from the standpoint of our body, we will be truly able to speak of semi-immortality.

Nanotechnologies also hide a serious danger of which we must always be aware, especially in the early stages of their development. Our body, and any biological system in general, is not equipped to oppose them. This is a good thing if we know precisely what actions they must be directed to perform, but it is a bad thing if they are left unbridled. To express it in extreme terms, without adequate precautions the nanorobots could quickly poison any living form because the immune systems are unable to recognize them as enemies: therefore, they might "accidentally" destroy tissues and organs. For example, it has been demonstrated that inhalating nanorobots that are present in the air provokes severe damages to respiratory functions. Again, technological progress will bring us closer and closer to semi-immortality, but, as it is always the case, we will have to learn how to manage it with respect and intelligence.

It is only recently that we have begun to actively deal with nanotechnologies in our research laboratory. In particular, we are focusing our work on the theoretical design of a carbon-based molecular computer. The ultimate goal is to apply the mathematics of the models of reference at the "physical" level by exploiting the peculiar characteristics of this material, not least the hexagonal morphology that typyfies the carbon-based molecular tissues[24].

3.6 Genetics

Jean-Baptiste Lamarck , who published the book "Philosophie Zoologique" in 1805, is generally recognized as the father of the concept of transmissibility of characters from parents to offsprings. After Lamarck, many other researchers, most notably Charles Darwin, continued to pursue naturalistic studies and unequivocally demonstrated that the characteristics of living species are not immutable. Before turning to more recent results, above all the discovery of the double helix structure of DNA that we owe to Francis Crick and James Watson, we must specifically mention D'Arcy Thompson, who back in 1917 showed the similarities in the morphological development of living species extremely different from each other by means of the powerful mathematical concept of transformation[25].

DNA (more precisely, the whole complex molecular system based on the information contained in DNA and RNA) is, in a nutshell, the "Instruction Book" of any living being. Although the human genome has already been fully sequenced and the concept of genetic code has come to become fairly widespread in a considerable portion of the population, we are still far from the thorough comprehension of how the whole mechanism actually functions, as well as from grasping the real meaning of all of its countless implications. By modifying the instructions contained in the DNA-RNA system, not only would we be enabled to make an organ appear or disappear, to alter its shape or position, but we might also change its functionalities. In other words, we believe that what is written in the DNA-RNA system is everything concerning the mind-body system of any living being, therefore, not only the hardware (which is quite "unbelievable" by itself, if you think about it), but also the software.

When we achieve a precise understanding of the mechanism we will be able to correct genetic errors (thereby resolving the related diseases) and to strengthen our resistance to many events that are harmful for our body, such as tumors, strokes, diabetes, hypertension, etc... We believe that such improvements will not be much related to a direct modification of the genes (ours or those of our offsprings), but rather to significant corrections to our software. This concept is new under many facets: let us then examine it in detail.

Our body is a machine in every respect. It is composed of many organs and physiological systems that are closely intertwined. Each organ possesses a certain degree of autonomy, although we know that the nervous system is able to influence any kind of event. To simplify matters, but not in any excessive way, we may state that the nervous system is under the total control of the brain. These instructions are inscribed within the brain in a language we don't know yet, but whose existence we are firmly sure of. Just as any change in the instructions of a computer program, any modification of such commands determines different behaviours on the part of the organs and the various physiological systems (circulatory, digestive, immune, respiratory, lymphatic, endocrine, etc...). Although imperfect in its design (the Great Engineer, if any, will possibly forgive us), our hardware comprises several self-repair and compensation mechanisms. The enhancement of such mechanisms by means of relevant upgradings in the software (which is far from being perfect as well) should guarantee us a key step towards semi-immortality. We may even not exclude the possibility that, in order to achieve semi-immortality, the improvement of the software might suffice, thus basically maintaining the hardware we are endowed with[26].

From the standpoint of our research laboratory, genetics is one of the cardinal elements in the route towards understanding how the software is written in our gene pool[27] and how this information is then stored within our brain, in particular with respect to the language employed. The access to this language will imply the ability to read it and the possibility, if necessary, to modify its contents. According to the classic Darwinian view, evolution would essentially occur by means of random mutations based on the parents' genetic code. If a given feature proves successful, then it will provide those individuals possessing it with competitive advantages, thereby increasing the likelihood of it being passed on to the offsprings. Without detracting from the substantial soundness of this position, we nevertheless believe that it fails to explain a few points, for instance, the speed at which the evolutionary dynamics would appear to occur. Therefore, we deem reasonable to hypothesize that what parents pass on to their children is not only the genetic code that has been present ever since one's birth, but also those characters acquired over one's lifetime (namely, those derived from direct experience[28]). One of the plausible places where to look for this typology of models of reference might indeed be what was, perhaps too hurriedly, defined as "junk DNA"[29].

[10] At present, there is no scientific evidence to prove that the universe is a space-time continuum, rather than discrete. Nevertheless, a few considerations may be formulated. The approach of classical mechanics, which is able to provide a satisfactory explanation of the macroscopic world, rests on a fundamentally continuous conception of space and time. In fact, at any instant and at any point, it is possible to univocally identify the quantities characterizing the state of a body with a degree of approximation that is suitable to our senses: therefore, for example, it is uncomplicatecated to trace the trajectory of its motion so as to determine its energy. The situation is different in the microscopic domain where quantum mechanics holds: starting from the Heisenberg's uncertainty principle and the Fourier's theorem, we have that: $\Delta i \; \Delta pi = h$ e $\Delta E \; \Delta t \sim h$ (where i is the i-th spatial component, pi denotes momentum along the i-th spatial component, E indicates the energy, t stands for time, h designates the Plank's constant). It follows that, as far as the interpretation of microcosm is concerned, as a matter of fact, we are led to identify discrete states for both the spatial and the temporal position. Obviously, also quantum mechanics resorts to computational approximations which, while being adequate to describe the reality at their level, might nonetheless fail to be accurate as far as the other levels are concerned.

[11] Present physics is confronted with the goal of establishing a quantum theory of gravity that is capable of combining quantum theory with general relativity also in order to understand the infinitesimal-scale structure of space-time. Among the many theories that have been proposed is that of Roger Penrose according to which the admissible quantum states are related to diagrams of lines and nodes called "spin networks"(by the way, such space would have a discrete geometry and space-time dimensions equal to Planck's quantities). And this theory would explain the early stages of life in the universe right after the Big Bang. Unlike general relativity, where space has a curvature due to the effect of gravity, quantum gravity metrics allows us to hypothesize a four-dimensional space with zero curvature (Minkowski's plane). Inasmuch as they are the coordinates of such space-time, *twistors* constitute its metrics and thus they are mathematical entities.

[12] We can use the globular clusters that form a system lying outside the galactic disk as a reference to measure the motion of the Earth within our galaxy. The

Earth, as the whole solar system, moves along the galactic plane in a direction perpendicular to the center, namely on a roughly circular orbit that it travels in a clockwise direction (viewed from the galactic north pole) at a speed of about 240 kn/s. It can be demonstrated that the galactic rotation results from a uniformly accelerated rotation of a rigid body and a Keplerian rotation, where rotation speed decreases with distance.

[13] Macroscopic quantities and phenomena that can be correctly described by means of classical mechanics are characterized by an objective nature that goes beyond any possible accurate measurement investigation we might undertake. Furthermore, it is possible to set a certain number of physical quantities such that, if they are known, then the results of all measurements that can be performed on the system are univocally identified. Not secondarily, this provides a "complete information" of the system itself. In contrast, quantum mechanics, which explains sub-atomic phenomena, displays a lower bound for the disturbance that is inherent to our observation. As far as the system is concerned, the measurement of a given quantity implies a perturbation that is not below the bound set by the theory, hence, on the one hand, it is possible to acquire knowledge on a certain component of the system, while, on the other, this leads to a perturbation, and thus an influence, on some other component of the same system. Hence, the complete information of the system becomes unattainable and so, more appropriately, we should speak of maximum information of the system. It follows that the acquired knowledge is of a statistical/probabilistic nature.

[14] In the context of quantum mechanics, Planck's law relates the energy of a particle to its frequency ($E = h.\nu$) or, according to particle-wave duality, it relates the energy carried by the particle to its frequency (h denotes Planck's constant). De Broglie's law states that $\lambda = hc / E$ (where λ is the wavelength, c stands for the speed of light in vacuum and E denotes the energy). It can be demonstrated that in the outer space, in proximity of a black hole, there exists a radius, known as Schwarzschild radius, which determines the boundary of the loss of information with respect to an external object. For a spherical symmetry, it can be found that the Schwarzschild radius is directly proportional to the mass of the object and inversely proportional to che speed squared. The constant of proportionality is the gravitational constant. After a few mathematical steps we find that: $\lambda = (G.h /c3)1/2$; $t = (G.h/c5) 1/2$; $m = (hc/G) 1/2$

(where h is Planck's constant, G refers to the constant of Universal Gravitation, c stands for the speed of light in vacuum, which is also constant). Substituting the numerical values of the constants allows us to derive the value of the so-called Planck's constants: length = $1,6 \times 10^{-35}$ m, time = $5,4 \times 10^{-44}$ s, mass = $2,177 \times 10^{-8}$ kg.

[15] The peculiarity of the rhombic dodecahedron lies in its twelve equal rhombic faces, a second characteristic is that it can be inscribed within a sphere (among the regular polyhedra is the one that occupies more volume within the sphere itself). Without getting too much into the debate here, it is however interesting to notice that also Plato had mentioned this topic in one of his dialogues, namely the Timaeus. According to Plato, the first creation of the divine Craftsman (i.e. the demiurge) precisely consisted in the four basic geometric solids, which are formed out the possible recombinations of the isosceles triangle (i.e. the cube, octahedron, tetrahedron, icosahedron), and which are assigned to the four elements that make up matter (respectively: earth, air, fire and water). Furthermore, Plato also indicated the existence of a fifth solid that would symbolize something similar to the future concept of ether (a possible basic composition of the universe). Whether Plato exactly referred to the rhombic dodecahedron or to the pentagonal version or to some other similar geometric figure is still a matter of debate. Nevertheless. The remarkable advantage offered by this polihedron resides in its ability to tessellate space evenly, with no gaps between one solid and another. This is precisely what allows us to conceive the rhombic dodecahedron as the possible primitive component underlying the construction of the whole real.

[16] The resolution of Maxwell's equations allows to determine the finiteness and the quantification of the speed of light. In classical mechanics, because of the finiteness of paths, the interactions appear as instantaneous in nature (Galilean relativity) therefore the speed of interaction and information propagation seems infinite. Nevertheless, it should be pointed out that this vision of reality is inaccurate and, if one of the interacting bodies undergo any change, its impact on another body in the same frame of reference will emerge only after a certain time interval: when such time interval, which may be extremely short, but not zero, has elapsed the latter body undergoes the change induced by the former. Dividing the distance of these two interacting bodies by the time interval of the interaction, we obtain the speed of interaction propagation, namely the speed of

propagation of a signal which should more appropriately be denoted as "maximum speed of interaction propagation". In nature, there cannot be any motion above this speed. The principle of Einsteinian relativity illustrates that the speed of interaction propagation is the same in all inertial frames of reference. Therefore, the speed of interaction propagation is a universal constant that is numerically equal to roughly 2,988 x 108 m/s, which is precisely the speed of light, inasmuch as information is carried by electromagnetic waves.

[17] Potential time can be defined as the time interval between two successive events or, more precisely, as the time interval wherein the succession of events is determined. This element is fully consistent with quantum mechanics' interpretation of nature according to which events are determined by a a probability of occurrence and thus potential time is when probability distribution is realized also as a function of potential interferences that might occur within the time interval.

[18] The application of the Heisenberg uncertainty principle to the study of the trajectory of the electron (note: the trajectory, not the position) causes the electron, as continuously perturbed by successive observations (interacting photons), to follow a zig-zag trajectory. The graphic images of the zig-zag trajectory and of the rhombic dodecahedron lattice are fully overlapping, although, for the time being, it is not appropriate to conjecture any further logical inference.

[19] To start our discussion let us assume fairly simple states and rules. Each elementary cell (i.e. a hexagon in the two-dimensional space) has seven states (six of which correspond to the directions of movement, while one is associated with the state of rest) and three values, or "charges" (1, 0, -1). Obviously, inasmuch as within our model motion is only apparent, when we state that a cell c with charge -1 has moved to the right over the time interval from t1 to t2 we mean that at t2 the cell on the right of c has taken charge -1 and the state of motion corresponding to the "right", while c has "turned off", thereby conveying the illusion of the movement of the charge. For now, we assume that the rules of motion are only local: the state of a cell at t2 exclusively depends on what occurs both within it and in the six adjacent cells at t1. In intuitive terms, the rules mimic "motion": if something moves to the right, then it will continue to go in that direction unless other forces or shocks intervene. The mechanics

of shocks is intuitive as well: when two cells are involved in a "frontal collision" they repel each other, thereby returning to their respective original direction. We want our small universe to be characterized by a "boolean" behaviour, namely a way of looking at events such that what happens in the abstract world of logical operators is physically reflected. As it is well understood, an algebra is nothing but a collection of elements upon which certain operations are defined: given the set of our values (1, 0, -1), we can define the behaviour of two fundamental operators, namely AND and NOT. We therefore obtain the equivalent of a succint three-valued logic that, besides "true" and "false", provides an additional, indeterminate value that is "neither true nor false". While it is fairly easy to identify what can represent values within our universe, it is far more complicated to understand how to realize the operators. Basically, there are two possible approaches: the first, and the easier, way is to create cells with *ad hoc* rules that reproduce the behaviour of the AND and NOT operators. For instance, an operation such as NOT would be realized within our universe by making an ordinary cell with charge 1 with a NOT-operator cell; thanks to the rules, the outcome would be a cell whose charge is now 0. The second, and the harder, way is to define the rules independently from the algebra, thereby causing the operator to "emerge" from the normal evolution of the universe. In its essence, an operator is something that makes a change: in particular, NOT may be considered from a functional point of view as an operation that produces a certain change, for example "charge reversal". This implies that any change in the charge of the cells which produces the correct effect qualifies as NOT. Hence, in this second type of universe, NOT may be the operation resulting from the "frontal" collision of two cells: the rules will ensure that such cells will bounce back after the collision, each reversing its charge. Beyond theoretical speculations, it should be remarked that the idea of a "Boolean manipulation" of the infinitely small is a research path that has already be undertaken by some laboratories. In particular, researchers from the Universities of Harvard and Princeton are currently investigating the possibility of building biological computers entirely made of DNA, RNA and proteins and able to compute Boolean equations within the cells. These "micro-conductors" will be able to take as "input" material from the cytoplasm and deliver as "output" molecules that can be easily identified in laboratory. What occurs at a biological level may perfectly and accurately interpreted as a small algebraic manipulation: the biological computer will produce "true", namely a molecule as output, if and only if within the cell there are, say, the components A and B or the component

C; in other words, what is performed is the evaluation of the Boolean formula "(A and B) or C". While waiting for further development of such techniques (which promise to enable us to evaluate the change of a single gene within a cell), this type of solution, where logic "emerges" from biology, is a conceptual result of utter importance. Even though they operate at higher dimensional levels with respect to our basic hexagons, these biological microcomputers provide a particularly telling example of the elegance of this approach.

[20] Monism is a recurrent temptation in the history of thought: the idea that reality is ultimately composed of a single type of entity appears as aesthetically pleasing, theoretically simple and intuitively more convincing than the obscure interactions between substances which any dualism seems bound to resort to. Neutral monism is the rarest and most inconvenient member of the family: though many in the past have reduced the physical world to the mind, and a multitude, especially today, have reduced the mind to the physical world, only few, in the past just as today, have seriously investigated the hypothesis that both the mind and the world are produced by the activity of one pre-existing, fundamental neutral matter. The physicist (and physician) Ernst Mach, who seeked for a unified and efficient theoretical framework within which to work, can be regarded as one of the most prominent neutral monists. William James considered experiences as prior to any categorization, "pure", namely neither mental nor material, but, potentially, one or the other: mind and matter, knower and known, thinking and thought, they are only the result of different "clusters" of pure experiences. Even Bertrand Russell, after years of "flirting" with the theory, came to embrace it explicitly in the 1920s: it was probably thanks to him that the interest in the theory has not completely vanished. In consideration of the problems of materialism, some philosophers of mind have recently reconsidered a return to neutrality; for instance, David Chalmers, argues that neutral monism may develop as a theory able to save, on the one hand, the elegance of reduction of monism and, on the other, the phenomenal qualities (i.e. the "*qualia*") promised by dualism.

[21] In the forties of last century, Konrad Zuse, a pioneer in the field of computers, hypothesized that, in order to predict its evolution, the universe may be associated to a huge self-referential computer. His theories were published in 1967 and found fertile ground in certain "techno-philosophical" circles. It was on these bases that Seth Lloyd has derived the theory according to which the

universe is an information processing machine and has introduced the concept of quantum computation, that is to say an instantaneous transmission of information through locations that may be light-years away. The problem of this phenomenon, as stressed by Lloyd himself, resides in the fact that the transmission of information would be faster than the speed of light.

[22] Richard Feynman's talk on December 29, 1959 at the *California Institute of Tecnology* marked the initiation of research and thus of the development of nanotechnologies. It is useful to emphasize the significance of the title: "There's plenty of room at the bottom". Particularly interesting is also the question at the beginning of his speech: "Why cannot we write the entire 24 volumes of the Encyclopedia Brittanica on the head of a pin?". Feynman's speech covered several topics, from the computer science domain (molecular computers) to the applications in the medical field, and it anticipated many of the main technological issues related to the construction of nanomachines.

[23] The miniaturization of grain metals or the incorporation of nanoparticles into alloys or polymers improves their mechanical resistance and modifies electrical and thermal behaviour as well as the resistance to chemical attacks. Nanoparticles are obtained in the form of nanopowders by means of different chemical and physical processes depending on the intended application. Their sizes are less than 10^{-7} m and the resulting product exhibits high homogeneity and purity. They can either be employed alone, by forming metallic and ceramic compounds, or mixed with other products. Silica and alumina nanopowders are used in abrasives, in particular in the field of computer science. Mixing nanopowders of Zinc and Titanium oxides with sun protection creams enhance their anti-UV radiation protection capacity. Iron-oxide-based nanopowders and Titanium-dioxide-based nanopowders allow to produce paints and dyes with better scratch resistance, improved ease of cleaning, higher resistance to organic solvents; therefore they are widely used in the field of metal coating, of fabric dyeing and in graphic and photographic art. Other applications are in the chemical industry (in particular, catalysts) due to their ability to increase the resistance of various materials. For example, in textiles it is possible to record a significant increase in anti-felting, waterproof, antistatic, anti-stain, anti-wrinkle, anti-bacterial and mineralizing properties. As far as the health sector is concerned, the main applications are related to bone implants where a better biocompatibility is coupled with an enhanced effectiveness thanks to the surface

nanoporosity. Finally, nanoparticles in the pharmaceutical sector enable the drugs to perform a more targeted action on cancers and allows us to use substances with low solubility within the human body.

[24]*Carbon.* Carbon atoms exhibit allotropic properties allowing them to aggregate within space in a variety of ways, thereby forming many different structures, in particular, graphite and diamond. The sheets of graphite are rolled up to form tubes, when only one sheet is involved the result is a single-walled nanotube, while multiple sheets wrapped into a coaxial cylinder form a multi-walled nanotube. Any deformation of cylinders, the imperfections or structural defects of the nanotubes are related to the closure structures that may be either hexagonal or pentagonal. The diameter ranges from 0.7 to 10 nm, their length is of the order of the millimeters; the unique properties of the molecules are ascribable to the ratio of 1 to 10000 between width and length: the single-walled nanotube is a material that exhibits a high resistance to traction. A defect-free single-walled nanotube is characterized by such a high breakdown voltage as to make it the best performing organic material able to compete, in terms of resistance, with monocrystalline inorganic materials: a synthetic fiber composed of carbon nanotubes would be the most resistant ever made, not to mention that, in terms of specific resistance, we would obtain an engineering material of the utmost importance. In addition to a high resistance to traction, the nanotube also exhibits formidable flexibility and elevated electrical sensitivity: in fact, they can be treated to become able to accurately detect the presence of high-voltage electric fields, inasmuch as, if adequately stimulated, they can bend up to 90° only to regain their original shape once the field is interrupted. Remaining in the domain of electrical properties, it should be noted that, depending on the diameter and the arrangement of carbon-carbon bonds along the circumference, a nanotube can become a conductor, a semiconductor or an insulator. Moreover, it would seem that, under certain conditions, the current can flow through the tube without heating it. And not only that: the conducting properties of nanotubes may be modified by, so to say, "doping" them; there exists a nanometer diode consisting of two nanotubes which allows the current to flow in one direction only. From the perspective of developing a molecular computer, a promising research avenue involves working with nanotubes where the current flow does not cause any heating; at this point, after placing them in the conditions to operate as semiconductors, they might receive a "drug" of a luminescent type (such as phosphorus) so that the "writing" obtained by means

of the flow of current is involved in stimulating or not stimulating – here is the binary code! - those phosphores which "store" the information and which are then "read" by a laser using carbon-based technology as well.

[25] C*hange of variable*. The process of decomposing a complex, or, in terms of processing costs, expensive problem into a series of simpler solvable subproblems is a general *problem solving* strategy: mathematicians, for instance, can translate a difficult multiplication problem into an addition problem (by using logarithms); physicists can think of extremely complex sound waves as the sum of different sine waves (by using the Fourier transform) so as to be able to study them. The trick is not unknown to Mother Nature grappling with the difficult task of populating the whole world with all the organisms we know. Darwinian theory and several biological discoveries have shown the outstanding "efficiency" of this evolutionary process that, starting from the same basic construction material, is able to give rise to an extraordinary variety (which is a bit like writing all the books in the famous library of Borges using only four letters! . In his exceptional work "Growth and Form", D'Arcy Thompson showed how Mother Nature not only saves on the building bricks but also on the projects. It is a fairly common experience to observe that a baboon skull is, in a way, similar to that of another primate, or that the shape of a certain fish is reminiscent of that of some other one. What is surprising is that there is a mathematical tool to formalize these ideas, and Thompson is the pioneer of such method. This solution is precisely the change of variable, namely a strategy that is used in statistics to interpret those results that would be non-significant otherwise. In fact, it is often the case that, when considering two graphs describing the same reality in two different spaces, the simple choice of unit of measurement gives rise to interesting phenomena such as the presence of symmetries or recognizable *patterns* in the trend of the graph. In other words, a function $y = f(x)$ may be completely uninformative, whereas its transform $y' = f(x')$ can be immediately enlightening: for example, if we understand why it is the square of x and not x to result in a regular configuration, then it implies that we have come to comprehend the fundamental law underlying such phenomenon, thereby eliminating all non-significant correlations. "Growth and Form", which laid out a quantative approach to biology, brought this method out of the boundaries of statistics, thereby revealing its general potential and modelling the steps of evolution by linear and non-linear transformations, one organism (i.e. "project") after another. The concept of change of variable proves extremely useful also

beyond its relevance in statistics and its biological aplications. The ability to "see the same thing from different angles" is certainly one of its many facets. Let us consider the transition from Chaos to Signs which is realized by a system moving upwards in the Spiral of Knowledge: as we shall illustrate several times throughout the book, reality in itself does not possess any natural veins or any metaphysical borders separating things (whatever this may mean); therefore, any organism dealing with the discovery of an environment must be able to move in the world by populating it with borders (and thus with recognizable objects).This is an impossible exercise without an array of regularities as a foundation for one's "bets". At this point, it should be clear that the more informative the regularities being discovered, the more reliable such bets: obviously, a system with access to multiple "spaces" in which to evaluate sensory data will be able to conduct better analyses. The instinct for regularity seems to underlie many discoveries: where many see only variation and complexity, sooner or later, someone realizes the possibility of a simpler systemitization. As a new vision of data is attained, suddenly, there emerges regularity and chaos is returned to order, an order that is different from what we were expecting and therefore surprising and significant. On the other hand, the ability to make analogies is surely somehow related to the recognition of similar *patterns* characterizing different phenomena. By means of adequate transformations, particularly gifted individuals are able to identify a similar, analogously equivalent trend in a distant reality: the more original the transform and the more "convincing" its result, the more the analogy will be a true work of creativity.

[26] From a certain point of view, if the hardware we are endowed with were sufficient to achieve semi-immortality, it would be quite a revenge for the "supporters of the Great Engineer", at least for the more conservative ones. Nevertheless, this is probably not how things stand. For example, we have always wondered what is the "sadistic" reason underlying the fact that our body is equipped with only one heart. In the event of a kidney, or an eye, or a lung failure, we still have another one. In the case of the liver, which is only one as well, it is however possible to have a decent quality of life even when a substantial part of it is cut away. In contrast, the heart must be almost completely intact and when it breaks there is no remedy. The next version of man's hardware will necessarily exhibit at least one additional heart, be it natural (by means of genetics) or artificial (by means of robotics).

[27] The *DNA*. Genetics is a branch of biology which is dedicated to the study of heredity, namely the process resulting in the transmission of individual traits from parents to their offspring. Throughout history, the results of crossbreeding experiments with plants and animals have demonstrated with certainty that both parents contribute to the characteristics of their offspring. Such contributions are transmitted through the gametes, namely the male and female sex cells: sperms and eggs. Around the mid-nineteenth century, Gregor Mendel, showed that hereditary characteristics are transmitted as discrete units whose distribution follows precise rules at each generation: such discrete units correspond to what we now call "genes". Most eukaryotic organisms, including man, reproduce sexually. Sexual reproduction requires two parents and it involves two processes: meiosis and fertlization. Meiosis is a special type of nuclear division, fertilization involves the process of fusion of the two parents' genetic contribution to form a new genetic entity. Each human somatic cell contains 46 chromosomes (i.e. the characteristic number of chromosomes for our species), while each gamete has exactly half the number of chromosomes found in the somatic cells of the organism. The number of chromosomes in gametes is called haploid (i.e. single) number, while the number of chromosomes in somatic cells is denoted as diploid (i.e. double) number. When a sperm fertilizes an egg, the two haploid nuclei fuse, n+n=2n and the dipolid number is restored. The cell resulting from the union of two gametes is called a zygote. Every diploid cell contains two equivalent versions of each chromosome. The pairs of matching chromosomes are referred to as homologous chromosomes and they consist of one paternal and one maternal chromosome. In the human life cycle, haploid gametes are produced by meiosis. When they merge in fertilization the diploid number is restored in the single fertilized egg cell. The fertilized egg develops into a male or female adult organism that in turn will produce haploid gametes. Thus, with the only exception of the gametes, the life cycle is almost entirely diploid. The phenotypic effects of a gene not only depends on the alleles of that gene in the organism, but also on other genes and the environment: the genes can change! There can be new combinations of alleles and true modifications in a gene, such as those that are caused by physical and chemical mutagens or by gene recombination (i.e.*crossing over*). One of the most fundamental properties of the genetic material is the ability to make exact copies of itself. The mechanism by which DNA reproduces itself is inherent in the double helix structure. When the chromosomes duplicate, the molecule opens up like a zipper and each old strand serves as a template for the production of a new one. Each strand forms

a copy of its original partner strand and thus two exact replicas of the molecules are formed. DNA is the carrier of genetic information that is encoded in the sequence of bases. Since the total number of base pairs in humans is approximately 5 million within the 46 chromosomes, the amount of possible variations is huge. If the DNA of one human cell were unwound, it would span a length of almost two meters, and it could store information equivalent to 600.000 printed pages, each containing 500 words. It comes as no surprise that the infinite diversity of living things can be explained by the DNA structure.

[28] *Can acquired traits be genetically inherited?* One of our research projects in the field of genetics aims at investigating whether it is possible that the modifications in the genes of living things occur not only due to physical and chemical agents or the *crossing over* mechanism, but also because of the transmissibility of acquired characters. This project intends to verify if, comparing the sex cells of the same individuals over time, any change in the genetic code can be found and, if so, whether such modification is ascribable to the acquisition of new models of reference; the "evolutionary mechanism" would consider these acquired models of reference of such importance as to transmit them to the offspring (a possible example might be the acquisition of some skill crucial for survival). If our hypotheses were to be confirmed, it would mark a remarkable leap forward towards the understanding of how and where the software is inscribed within the DNA, namely the true ultimate goal of our research in genetics. A recent research project coordinated by Christina Lindqvist (Plos One April 2007) reports the results of a study conducted on animals of two different chicken breedss, namely the *White Leghorn* and the *Red Jungleflowl*. The former is the chicken breed par excellence, which has long been bred and selected for egg production, while the latter is a more "ancient" chicken breed that might be regarded as the ancestral breed from which the former derives. The goal of this study was to evaluate whether the offspring of these animals could inherit certain behavioural changes induced by stress and captivity conditions that were verified through given tasks such as the search for food after periods of prolonged fasting. To this end, learning tests were carried out on both chickens subjected to stress and on control chickens not subjected to any stress. Furthermore, investigation was directed at detecting, at a molecular level, possible changes in the gene expression of the hypothalamus and the pituitary gland, namely the brain areas involved in stress responses, by comparing the chicken subjected to stress to the control chickens. For both the parents and the

offspring born from stressed parents, such analysis was performed through the use of microarray. Test results have shown that stress significantly reduces the learning abilities in both chicken breeds, even though RJF chickens exhibit a better reaction to stress. The explanation is probably to be found in the fact that the RJF, being it a primitive breed and thus more accustomed to get hold of food, encounters fewer difficulties than the WL which had been selected in captivity. As far as the analysis of the gene expression is concerned, the results showed that there is some correlation between parents and offspring in the WL population, but not in the RJF one. Finally, considering both behavioural and genetic tests, the authors conclude that both behavioural changes and modifications in the gene expression occur in the WL breed, but not in the RJF one. There are two possible explanations to the phenomenon: on the one hand, the epigenetic agents, as modified due to stress, might have been directly transmitted to the offspring; on the other hand, the epigenetic factors could have been acquired *de novo* in the eggs, for instance through the action of stress-related steroid hormones released by the mother.

[29] *Junk DNA* . Molecular biology defines noncoding DNA as each DNA sequence in a genome which is not subject to transcription into RNA or is removed from the mRNA before translation occurs and whose functions are, at the current state of knowledge, still unknown, even though several hypotheses have been advanced to explain its role. The scientific community often refers to these DNA regions as "*junk DNA*". Despite their exceptional media visibility, the results delivered by the Human Genome Project have failed to confirm the expectations placed upon it by molecular biology as well as to meet the original objectives of the research. In fact, the human species was thought to possess hundreds of thousands of genes, yet, so far, only about 30.000 have been identified. The mapped genome has clearly revealed that genes represent only 3% of the total: all the rest is made of material whose operation and purpose are still unknown. According to some scientists (including Evelyn Fox Keller, author of "The century of the gene"), these considerations and recent researches may be able to seriously put into question the classical conception of the gene as a stable molecule, subject only to random errors, as well as the accuracy of Darwin's theory intended as a process of natural selection acting a posteriori upon such random mutations. Now that we have come to read all the DNA, we need to understand how the genes operate and, perhaps more importantly, what is the role of each of them within the cell. This domain

witnesses a new discovery almost every day. Early attention focused on those genes that, when not working properly, cause the five thousands known hereditary diseases (by now, almost all the genes have been identified). However, this research path proved more difficult than expected. To make an example: after identifying the gene that causes cystic fibrosis (which is one of the most common genetic disease as it affects one in 2500), the researchers have discovered that there are 700 versions of the same gene, all capable of causing the disease. Even more complex is the study of genes that, if damaged or activated at the wrong time, can lead to cancer: the functioning of DNA varies depending on the affected organ, the tumor type and stage of disease. In conclusion, the identification of a truly effective cure for many diseases requires a thorough and detailed knowledge of the genome and how its functions. The ability to observe the unwinding of the DNA chain has revealed a surprising piece of information: genes are never orderly arranged on the double helix, on the contrary, some sections exhibit hundreds of genes in a row, whereas none of them are present on other long streches of the strand. As mentioned above, the purpose of some 95-97% of the DNA chain is still unexplained. Then, why is it there? We may surmise that in the past it must have played an important role. It may contain some "fossil" genes that were useful to our distant ancestors, but over time have become redudant. In order to shed light on these questions, we should compare the genomes of many species, but so far only the genomes of the fruit fly and mouse have been extensively analyzed (in addition to those of yeasts, bacteria, etc...). In the meantime, it has been discovered that at least part of the "junk DNA" is extremely useful: long, "meaningless" sequences surround the most delicate points of the chromosomes when the cells duplicate, thereby protecting the genes against some enzymes in the cell which may break them. Nevertheless, the mistery remains for most of that 97%: there is a fish (i.e. *fugu rubripes*) that has very little DNA, much less than other fish of the same size and similar life conditions. It would appear that, at least in this case, a large amount of "silent" DNA on top of the useful one is not necessary. However, we are still far from a thorough understanding of 3% of the "useful" DNA. The genes often exhibit a "bizarre" shape whose underlying reason is not comprehended: often, they are hundreds of thousands of bases long (reverting to the comparison already used, is equivalent to at least a dozen magazine pages), but the "functioning" part is very small (on average, 10 000 bases) and split into pieces separated by "useless" DNA. The silent segments within genes are called introns and, at times, are so long that they contain other small genes. For example, the gene for factor VIII is approximately 186 ooo bases long and three small genes, whose function is still unknown, have been found within its introns. As far as the operation of the genes is concerned, the findings are even more surprising. Often a single gene can give rise to several different proteins. This occurs when the instructions it contains are not fully copied: thus, there will result, for instance, a long protein located on the cell membrane (when the gene has been completely transcribed) or a smaller protein which then enters into circulation within the cell (when the gene is transcribed only in part). Furthermore, many genes are activated only at a particular stage of the individual's life (fetus, child, adult) and only in certain parts of the organism. Nevertheless, the so-called gene regulation (namely, the set of instructions that tell a portion of DNA to function in a certain way rather than another) is still largely unknown. In this respect, it should be mentioned the work of Edoardo Boncinelli on homeogenes, i.e. the genes that regulate the operation of other genes.

4. Artificial Intelligence

Can you exactly remember how automobiles were born? When you get in your car in the morning, how many of you recognize that such car is nothing but the technological evolution of the horse-drawn carriage? A genuinely amusing exercise is to review the chronicles of the early Twentieth century through today's eyes. The first impression you get is that our great-grandparents were really naive. Why should they have ever let themselves be so concerned (and fascinated at the same time) by that "blatant instrument of the devil which will surely bring our civilization to ruin"? Another example is the microscope. How could many tenaciously maintain that "if the good Lord had wanted us to see also those strange things, he would have given us different eyes"?Were they naive as well?

As a matter of fact, within us resides the instinctive fear that some of our actions may cause a progressive loss of control over the instruments we create, up to the extreme case of a possible irreversible alteration of life on Earth. Perhaps it's not a wholly unfounded fear: we might even risk to end the Game with no winners. In short, we wouldn't be speaking of naivety at all, but rather of a healthy self-preservation instinct! However, if this instinct is left free to prevail without any control, we land at superstition, we turn away from reality and we get closer to death. Hence, we cannot help but embrace the invention of the microscope that, among other things, led to a spectacular reduction in the deaths related to the action of bacteria.

A very similar argument applies to artificial intelligence. Every time we manage to transfer the functionalities of one of our organs to a machine, we are frightened and fascinated at the same time. This was the case with the introduction of photography, phonographs and robots in the assembly lines. Artificial intelligence is concerned with transferring functions from the organ we value most to a machine, nevertheless the underlying concept is always the same: optics is to the eye as artificial intelligence is to the brain. From the standpoint of men, the brain is attached more importance than the eye, but, from a functional point of view, it is just equivalently an organ. We are fascinated by all this because we instinctively know that these innovations will bring about considerable improvements in both the quality and the quantity of our life. But at the same time we are scared since we instinctively know that the more significant the step is, the higher the risk of destroying everything.

4.1 The Origins

As far as we know, the earliest man's attempts to deal with the human mind in a direct and functional manner date back to Pythagoras in the sphere of the Western cultural tradition and to Buddha as far as the Eastern cultural tradition is concerned. For one of those coincidences that delight our analogical mind, we know that the two philosophers lived at the turn of 500 B.C. and it is probable that, for some years, both were alive at the same time. Neither of them left any written record, therefore we can only make conjectures about their own paths relying on what their disciples/students have indirectly handed down to us.

Both formulated a thorough view of the whole and both devoted a considerable amount of time and effort to reflections on the nature of the human mind. In a sense, we may state that Pythagoras specialized in logical thought, whereas Buddha specialized in the analogical one. We would not be excessively startled if tomorrow we found out that the two philosophers had never even existed and they actually were nothing but symbolic figures, cultural expression of a civilization. The historical relevance lies in the fact that about 2500 years ago two or more people embarked in the attempt to understand the mechanisms underlying the functioning of the human mind in a way that today we might call “scientific”. Pythagoras'views began producing valuable mathematics, while those of Buddha began generating valuable psychology. We reasonably assert that programming languages find their ultimate origin in Pythagoras and psychoneurophysiology find their ultimate origin in Buddha. In order to adequately develop, artificial intelligence needs both.

4.2 From 500 B.C. to 1950 A.C.

Pythagoras and Buddha have paved the way and thenceforth many other scientists contributed to the understanding of how the human mind (and the whole) functions. Pythagoras had many illustrious heirs over the subsequent three centuries, most notably Aristotle. Then, for nearly 2000 years, until 1600, the Western civilization has put its interest in the mind's operation on hold. Probably, almost the entirety of people were satisfied with the Christian view of God as immanent creator. At the the end of the fourteenth century some researchers resumed the organic reflections on the mind and the whole (for example, Raimundo Lulio), but for another truly rigorous treatment of this topic we have to wait until René Descartes and, most of all Gottfried Leibniz and Blaise Pascal.

In the Eastern civilization, almost nobody was able to resume the researches of Buddha with a comparable innovtive strength. As far as we know, many Buddhist schools continued the studies in the psychological domain, but they didn't contribute with any truly significant modification[30]. It is only in recent years that the contact with Western science has enabled many scientists from Eastern culture to go on (and very effectively) with the work started 2500 years ago. A special recognition must be given to the Arab scientist Mohammed al-Khwarizmi who, around 800 A.C., engaged himself in the attempt to unify Greek and Indian mathematical cultures. We owe him the concept of algorithm that can be justifiably regarded as a fundamental step in the development of artificial intelligence.

In the Western world, the Seventeenth century marked the beginning of a slow but steady progress towards the acquisition of adequate tools to realize the reproducibility of human thought. Later, there have been many scientists who dealt with it, most notably two: George Boole and Charles Babbage. The "logical" Western cultural tradition and the "analogical" Eastern tradition started to reunite in the late Nineteenth century. The march of artificial intelligence (and of the understanding of the whole) could then continue on the right track. The scientist who is generally recognized as the father of modern artificial intelligence is Alan Turing: the birth certificate might be symbolzed by his article "Computing machinery and intelligence"[31], published in 1950. In the immedeately previous years, several scientists had dealt with this issue thereby crucially paving the way. In this regard, we like to mention Bertrand Russell and Kurt Goedel. Furthermore, in those exact same months, at least two other scientists were developing some extremely brilliant ideas belonging to closely related fields: Norbert Wiener (the father of cyberneticc) and John von Neumann (the father of electronic calculators).

4.3 The latest 50 years

The advent of electronic calculators has produced a remarkable acceleration to the development of artificial intelligence. The possibility to exploit elevated computing capacities represents an essential tool for the comprehension of how the human mind functions. For a considerable number of years the scientific community has focused almost exclusively on the physical level of the process, for example, trying to reproduce the functioning of our neurons. Needless to say, the results were far below expectations. The same fate has befallen the attempt to reproduce the biological evolutionary mechanisms. All these approaches attempted, perhaps naively, to make intelligent behaviours emerge solely from the method. A few somewhat more blurred approaches, which focused attention not only on the binary concept of true/false but also on its intermediate states (almost true, almost false, yielded results of geater practical usefulness. We do not mean to underestimate either the utility or the ingeniousness of these approaches: they allowed the achievement of extremely interesting results, real technological gems that were just unthinkable only a few decades ago. For instance, without neural networks[32] we wouldn't have the systems of automatic recognition, without genetic algorithms[33] data analysis would be much poorer and, above all, without Lofti Zadeh 's *fuzzy logic*[34] most consumer electronics (two of the most prominent examples include digital cameras and Mp3 players) simply would not be available to us. Also the simple brute force search method[35] has proved of crucial importance in many areas, allowing us to sequence human genome, to construct search engines in the Internet and, in the year 1997, to design a computer capable of beating the world chess champion. Today, the most powerful machines are capable of processing more than one million of billions operations per second[36], a huge number indeed. Notwithstanding these progresses, it cannot but be remarked how still distant we are from reproducing the human mind.

4.4 The next two objectives: learning and consciousness

The scientist John McCarthy, the father of the programming language LISP, must be credited for being the first ever to use the term "artificial intelligence" on the occasion of a now historic interdisciplinary seminar held in 1956[37]. Both consistently with the original idea and in accordance with the opinion of many other researchers (see, for example, Marvin Minsky), we can define artificial intelligence as the science that studies how to reproduce the mental faculties of man. As we have observed, it is a very controversial topic for it often affects the personal sensitivity of each one of us. It is difficult to consider it impartially without triggering beliefs, aspirations, fears. The key question might be formulated as follows: "will machines ever attain mental faculties comparable to those of man?" There are scientists who deem it possible and those who do not deem it possible. The former adhere to the so-called "strong version" of artificial inteligence, whereas the latter belong to the "weak version"[38]. We believe that in order to attain semi-immortality it will be necessary to create artificial systems such that they are as close as possible to the mental faculties of men. In particular, we can identify two primary objectives to be achieved in the coming years: the exact understanding of the mechanisms underlying learning and the reproduction of what might be defined as the activity of consciousness. Edward de Bono and Humberto Maturana are only two among the many other scholars, besides the aforementioned ones, who have dealt with these issues in an intelligent and innovative manner.

If these two objectives are fully achieved (strong version of artificial intelligence), then immortality will be within our reach and machines will normally become a part of our relational world. And perhaps we will be considerably closer to the Solution to the Game. If these two objectives are only partially realized (weak version) we will have to hope it will nevertheless be sufficient for attaining a significant extension of our life span. However, the Solution to the Game will probably be still very far.

Nevertheless, artificial intelligence will prove able to perform several crucial functions in the path towards semi-immortality. First and foremost, it will allow us to attain a thorough understanding of our mind's operations thereby enabling its enhancement and its repair in the event of deterioration. Secondly, together with medicine and psychology, it will foster the comprehension of the complex and profound connections between mind and body; this will allow the prevention of diseases and, in a perspective of semi-immortality, it will critically contribute to the treatment and recovery processes. Thirdly, together with nanotechnologies, it will permit us to provide the nanorobots that will be assigned the task of repairing the cells in our body with actual intelligence. Finally, it is not difficult to discern how useful such indefatigable assistants might prove in any branch of science, not ony, as it is the case today, from the standpoint of pure calculation, but also providing a valuable creative approach to the most diverse problems.

4.5 The state of the art

In order to describe the current state of the art of artificial intelligence we must start to draw a picture of the concept of Spiral of Knowledge. So as to simplify matters, but not excessively, let us examine the path of any given data item from the moment our senses detect it to the moment our mind "understands" it.

Chaos => Signs => Values => Meanings => Understanding => Knowledge

Each of these steps requires a considerable leap in terms of system intelligence. Current softwares can well perform the first step, namely the one leading from Chaos to the identification of the Signs. As examples of this type of programs, we might mention the OCR softwares (i.e. those that are able to recognize text within an image; they have been on the market for roughly ten years already) and speech recognition programs (which are employed in the most advanced phone help desks). Some PalmPCs can recognize pen-written text, hence, starting from a plain sheet of paper, they are able to convert handwriting into fonts that can be stored by the PC: in other words, the software turns the "scribbles" (Chaos) into alphabet letters (Signs).The study of the transition from Chaos to Signs led to the birth of digital photography (have you ever wonder where does the concept of "white balance"[39] come from?), of the audio/video compression systems[40] (Mp3, Jpeg, etc…) and of many other technological amenities. However, as sophisticated as it is, current technologies has nevertheless considerable limitations if compared with what our mind can do. Take for example the field of speech recognition. Today, a good software is able to translate speech into text with a certain degree of reliability only under very controlled conditions (only one speaker, limited background noise, preset dictionary, etc…). This is not much due to the fact that we haven't understood the physics underlying the process yet, but rather it's because the software is still stuck at the first step. In other words, "it doesn't understand what it hears".

What does "understanding" mean?

Understanding means being able to associate a given data item that is detected by our sense with a system of representation of reality. A system can "understand what it feels" when it possesses a system of representation of reality and it is able to modify the model itself as to adapt it to the progressively collected data. At present, the softwares on the market are still

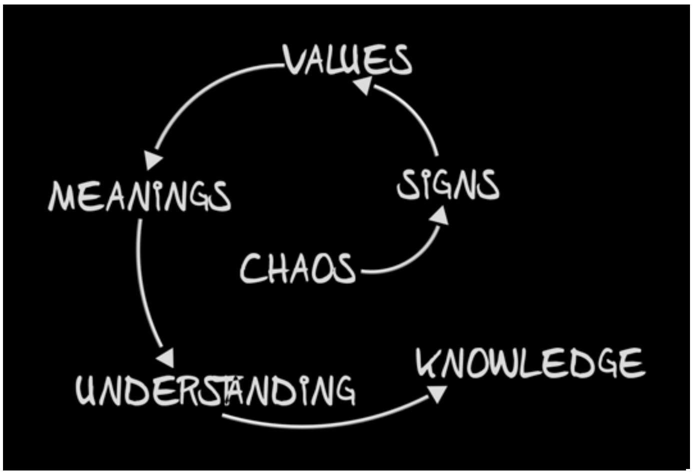

Fig. 4.1. The Spiral of Knowledge.

very far from such an achievement. At best, what we are able to affirm today is that, from a computational standpoint, artificial intelligence has just entered the sphere of Values.

4.6 The near future

However, there is a hypothesis which, should it be confirmed, would allow to significantly reduce the time required to reproduce the whole path of the spiral. It is possible that all the transitions work in the same way, that is to say that the operators allowing to move from Chaos to the Signs are just the same that enable our mind to move from the Signs to the Values, and so on. Closely tied to this concept is the idea that, according to such hypothesis, the operators are always the same regardless of the sense involved (sight, hearing, taste, etc...) and of the perception level. Our researches induce us to be optimistic about the validity of this hypothesis and this is why we speak of a Spiral of Knowledge. Moreover, such spiral is probably applicable to any living form.

A further trend we are focusing on, and which will be discussed in the chapter devoted to self-reference, is the progressive increase in the degree of awareness of the programs. This idea stems from our extensive study of people's mental faculties; we asked ourselves: "what is that distinguishes particularly skillful people from the others?". Of course, the set of initial conditions, experience and the specific technical competencies has a considerable weight. But, ceteris paribus, there seems to exist a crucial difference, namely, the ability "to look at what one is doing while doing it". Those who make an intensive use of their own mind's self-referential ability achieve a substantially higher level with respect to those who do not. In the domain of psycometric testing, the term that comes closests to this concept is "metacognition"[41].

The self-referential ability of a system (be it a person, an animal, a company, an organization, etc…) is likely to significantly contribute to its overall intelligence. The application of this concept to the development of software opened the way for a new generation of programs. A software can be defined as self-referential when it "knows" what it is doing (i.e. it becomes aware), it is able to discern whether its action is correct or not (i.e. it evaluates) and it is able to execute the actions that are useful to improve its own performance (i.e. it acts).

There already are a few softwares that contain some tentative self-referential hints. As a typical didactic example of self-referential program, we can mention the one that is able to visualize, and thus reproduce, its source code (i.e. its "quine"[42], the term is named after the philosopher Willard Van Orman Quine). Within some programs, there exist specific modules that deal with monitoring and evaluating the performance of the programs themselves. For instance, they spot when a procedure is too slow or misused and then they start to propose programmers possible corrective actions (increased controls on a given field, feasible simplificationsn, improvements in the online *help*, etc…). They "discern" if an error is serious and whether it depends on the user or not; they "know" the system's normal response time and therefore they are able to recognize possible anomalies. In case of situations they deem necessary of attention, (and if the client is fine with it) they can directly give immediate signalling to the assistance services. The concept of self-reference occupies a prominent position also in psychoneurophysiology. According to our researches, it is the true active principle of the self-healing processes.

Artificial intelligence is the science that will allow the development of machines endowed with personality and mental faculties comparable to those of men. In the following chapters we will examine the main steps that must be taken in order to attain such an outcome.

First, we will analyze the mechanism of learning and we will try to understand how we can get from the apparent chaos perceived by our senses to the comprehension of the context actualized by our mind, as well as how, after the necessary steps, knowledge can emerge. Next, we will investigate in depth the concept of self-reference and how it is possible to equip a machine with consciousness activity. Self-reference will take us to the cardinal chapter devoted to psychoneurophysiology, namely, what, at the present stage, constitutes the main yardstick to gauge the merits of our approach and which often produces the non-negligible effect of enabling people to improve their physical and psychic parameters. The reader patient enough to follow us that far will finally be offered a concise description of our model for representing human mind and the related mathematics of the models of reference.

[30] It can be argued that Dignaga (fifth century) and Dharmakirti (seventh century) were the two most influential thinkers of the Buddhist tradition. In fact, they were the founders of what is generally defined as "Buddhist logic". In many respects, they can be considered as the "eastern" culture equivalents of Plato and Aristotle .

[31] *Computing machinery and intelligence*. It is at least curious to find that the father of *computer science*, i.e. the genius mathematician Alan Turing, considered the "Can machines think?" question as too vague to be meaningful. In his historic article "Computing machinery and intelligence", which was published on *Mind* in 1950, Turing proposed to replace it with another and related question. Such proposal, which revealed that his outstanding acumen was not confined to the domain of logic, consisted in playing the "imitation game". There are three players, namely X, Y and Z; X is a man, Y is a woman, Z is the interrogator: without seeing the candidates, Z must guess which of the two is the man and which is the woman. Hence, the question concerning the intelligence of machines may be rephrased as follows: "What would happen if a machine took the place of X?"; or, in other words, might the interrogator, as deceived by the answers of the computer, fail to correctly identify the players? The crucial insight underlying Turing's approach is the following: the manifestation of an intelligent behaviour such as success in the imitation game is to be regarded as an unquestionable symptom of thought; it would therefore be possible to attribute intelligence to any system exogenously and with a sufficient degree of reliability without having to struggle with countless questions about the nature of mind, consciousness and mental representations. In fact, Turing pointed out that, in most human relations, the attribution of intelligence to the others rests on only few additional inputs with respect to the setting that was imagined for the game! And more than that: the test is clearly conceived to be carried out on systems with limited, non-mental abilities; this is why such test does truly evaluate intelligence.Turing, in his 1950 paper, considered and rejected several objections to the idea that a machine might pass the test, including those raised by the philosepher and the common man in the street. If it is true that any claims about thought as a prerogative of the human mind may sound somewhat silly, it is equivalently true that arguments supporting the impossibility of mechanizing creativity and flexibility are still central in the debate on artificial intelligence. With resolution and surprising far-sightedness, Turing remained

unfazed, arguing that many concerns about the abilities of machines appeared as entirely based on the memory-related limitations of the tools of the time. Finally, the article closes with a few interesting observations about the relationship between machines and the environment, such ideas somehow got lost in the early years of artificial intelligence only to reappear later as "revolutionary" concepts along with connectionism. In particular, identifying memory and programming technique as the key to success, Turing advanced the hypothesis of designing an "infant" mechanical mind to be instructed by a teacher so that, as an adult, it would eventually manifest enough intelligence for the game. Even today, there are a number of objections to the Turing's test: some have argued that passing the test, by itself, ultimately is not a sufficient condition for the attribution of intelligence. After all, it is argued, who will guarantee that the computer might not win by selecting a huge, and pre-set, number of possible courses of action for the conversation? Nevertheless, if we reflect a moment on this argument, we will realize that such hypothetical computational deception is not actually implementable in any satisfactory way and thus that this objection is probably unrealistic. More convincing are the arguments of those who maintain that the passage of the test is not to be taken as a necessary condition for intelligence.: the stand of refusing to attribute mental faculties to children or primates only because they are unable to play the imitation game seems quite out of line. In conclusion, those who have dismissed the test with contempt as a "behaviourist" test have simply underestimated its ratioanale and its merits; if a bit of "behaviourism" is really there, certainly that corresponds only to the good and flawless part of it: whatever may be thought of mental states and faculties, it is however necessary to identify some way to relate such part to how, given certain inputs, the subjects produce certain outputs, including conversations.

[32] *Neural networks*. There is a broad consensus among engineers, biologists and scientists on the fact that one of the most amazing computing machines is just behind our eyes, within our cranium. Essentially, our brain is a network of neurons which computes, stores and learns information: on one side of this huge network are the input data neurons, while on the other side the output data neurons that transmit information once the computation is completed. In between there are billions of neurons which all run according to the same simple logic: the cell sums up the incoming signals, compares the value obtained with its own threshold and, then it propagates the signal if and only if the threshold is exceeded by the input signal. Therefore, it may be surprising that,

from the Fifties to present, most of information technology rests on a completely different paradigm of computing which is fundamentally based on the performance of a certain number of sequential operations on a certain number of data. Beyond the historical and cultural reasons underlying this situation (in fact, a software for PC is the natural evolution of a Turing machine), the development of biologically inspired computing systems has long been affected by technological problems. Already at the end of the Fifties, Frank Rosenblatt proposed his famous perceptron, namely the grandfather of neural networks, but, ten years later, Marvin Minsky and Seymour Papert demonstrated that these simple neurons couldn't compute even elementary functions such as that of the exclusive OR. It wasn't until the advent of the new mathematical techniques developed over the following years that it became possible to come close to reproducing the brain's architecture: in particular, those allowing us to handle those neurons that stand between input and output which are precisely the key to complex computations. Modern neural networks are composed of input, *hidden* (i.e. a series of internal layers) and output neurons. In its simplest form, each neuron merely multiplies the input by a certain value called "weight" and then transmits the information only if the result exceeds the set threshold value. In practice, the weight codifies the importance of the communication connections between two neurons: the more relevant the connection, the higher the weight. An important peculiarity of neural networks is their learning ability: unlike the softwares that are specifically programmed to deliver certain outputs, neural networks can intelligently evolve by adequately modifying the connection weights, thereby rapidly converging towards the desired sophisticated behaviour. In particular, an algorithm known as *backpropagation* (which was developed in the mid-Eighties) enables the network to generalize from a limited number of examples by learning to properly deal with inputs it has never seen before: the first (and perhaps the most spectacular) successful results of this approach are those obtained in the sphere of various *pattern* recognition. The flexibility of neural networks somehow follows the ability of complex organisms, such as man, to learn from experience, refining the accuracy of one's response to environmental stimuli at each iteraction. Beyond the technical details, the recent interest in neural networks not only stem from their important applicative implications, but also from "philosophical" reasons: in fact, many scholars in the field of artificial intelligence see this line of research as being far more fruitful than the traditional "logicist" approach. According to its advocates, this "philosophy" is able to convey significant advantages including, first of all, the biological plausibility of the underlying mechanism, secondly, the ease of learning and generalization starting from examples, not to mention the appeal of parallel computation and the robustness of systems that ensure an adequate performance even in the event of damages. Nevertheless, researchers with classical foundations emphasize that, on the one hand, there are still major limitations to the reproduction of truly complex behaviours (which are presumably marked by a significant *top-down* necomponent of processing), while, on the other hand, that such advantages are more formal than substantive (for instance, the computing capacity of the networks is not greater than that of classical sequential devices). Perhaps, the "real" difference between the schools of thought lies in how they represent the knowledge of a system, either explicitly and symbolically, or implicitly and in a distributed fashion. We cannot rule out the possibility that a combination of the two approaches may bring about excellent functional results.

[33]*Genetic algorithms.* One of the most interesting pieces of evidence supporting the mechanism of evolution as conceived by Charles Darwin is its universality. In fact, the Darwinian principles of mutation, selection and adaptation not only apply to biological phenomena, but they also apply to cultural and social phenomena (consider, for instance, the extensive application of evolutionary game theory in social sciences). The mid-Seventies witnessed a further generalization of the dynamics of evolution, this time in the domain of computer science. The pioneering works of John Holland marked the birth of the first genetic algorithms, namely heuristic data analysis procedures that allow us to efficiently identify the solution to extremely complex computational problems. It is not difficult to recognize the theoretical contribution of Darwinism in the philosophy underlying this approach: starting from a population of different algorithms, it can be seen how distant they are from the desired solution. The fittest algorithms "breed" at a higher rate, thereby giving rise to a new generation of individuals which, in turn, will be subjected to evaluation. If we also introduce random mutations that occur within the population with a certain statistical incidence, then the evolution game is almost done: this mechanism is able to produce, from generation to generation, increasingly efficient algorithms, even though, obviously, there are no a priori guarantees that evolution will actually supply the individuals that are optimal for the environment. Formally, evolution is shaped by processes that are exactly analogous to the biological ones. The population is constituted on a random basis and an ad hoc *fitness*

function assigns each algorithm a certain value representing its efficiency with respect to the solution. Once the algorithms have been sorted by the *fitness* function, there begin those operations that will determine the characteristicss of the next generation, namely copy, *cross-over* and mutation. In fact, the most promising algorithms are able to generate identical children, or, alternatively, they can "mate" via *cross-over* to form a new offspring with new characteristics. In the simplest case, two algorithms are "cut" at some point to produce two new strings by mixing "heads" and "tales". In contrast, mutation is a process that involves a single algorithm at a time and it simply consists in modifying portions of the strings of certain genes. Copy, *cross-over* and mutation are not implemented without distinction: in fact, each individual in the population has a known probability of being the object of one of the three operations. Obviously, *cross- over* and mutations are intended to ensure that the procedure actually explores the widest possible part of the tree of solutions. The main field for the application of genetic algorithms is the optimization of those process for which there are no known classical algorithms at present, including problems where the objective function is discontinuous, non-differentiable, stochastic, or markedly non-linear.

[34]*Fuzzy logic.* If the beginning of the Twentieth century was marked by the consolidation of the methods and the "philosophy" underlying classical logic (i.e. that of Gottlob Frege and Bertrand Russell), the second half of the century saw instead the flourishing and development of a set of new logics conceived either as an extension of the orthodox approach, or as true alternatives to such framework, or as tools tailored for particular applications. One of the most interesting among these is the *fuzzy* logic, which owes its invention to the pioneering works of Lofti Zadeh in the Sixties and Seventies. This logic can be thought of both as an extension of classical logic, as a revolution and, finally, as a logic that is relevant in the application phase. In a nutshell, the whole philosophy underlying *fuzzy logic* can be captured by the saying "things are never black or white": in fact, while the traditional approach typically classifies statements as either true or false, *fuzzy* logic instead accepts different values of truth, such as "very true", "neither true nor false", "almost false", etc... Technically, this idea is realized by using the real numbers: while, classically, interpreting a language means assigning 1 (i.e. true) or 0 (i.e. false) to atomic formulas, *fuzzy* logic allows every proposition to be associated with any value in the continuous interval [0, 1]. By the same token, according to the theory of *fuzzy* sets the membership of

an element in a set is no longer an all-or-nothing, but, rather, several gradations are admitted: a two-meter basketball player is undoubtedly tall, a person who is one meter seventy will be neither particularly tall nor particularly short, finally a person who is one meter forty will be certainly clssified as not tall. This implies that the degrees of membership of these individuals to the set of tall persons vary along the continuum ranging from 0 (i.e. the not-tall person) to 1 (i.e. the undoubtedly tall person). We can interpret the *fuzzy* logic as a generalization of the traditional approach in the sense that the classical values 0 and 1 are a subset of all the values that are admitted by the new logic. However, it should be borne in mind that the *fuzzy* logic was primarily developed for applicative purposes. As we substitute a "Platonic" world characterized by clear boundaries with a world in which it is unclear where the systems begin and end, there emerges the substantial need to identify new formal tools to model reality and any reflection concerning it. In this respect, *fuzzy* logic has, for decades, been one of the "technological" logics par excellence: the year 1985 saw the construction of a *fuzzy* controller for the Sendai underground which can be regarded as the first significant practical application based on the *fuzzy* approach. Thenceforth, there has been a proliferation of such applications in a variety of sectors including industrial process and control systems, the operation of various household utensils, automatic camera adjustment, the control of vehicle braking. Of the utmost interest are the applications to diagnostic softwares such as medical diagnostic decision support systems.

[35]*Brute force*. The term "brute force" denotes a computational approach that essentially rests on the ability of computers to perform calculations quickly. An illuminating example is provided by the game of chess. Both the difficulty and the fascination of chess lie in the fact that, when considering all possible next moves of both players, such number quickly grows so large that any ordinary person will be able to predict at most a couple of them while a particularly trained one no more than four or five. Therefore, the chess player does not examine all the different possibilities, rather he selects from a number of possible paths those that are believed to lead to victory with greater ease. A theoretical machine with unlimited computing power would be able to simultaneously evaluate all the possible moves and counter-moves to always determine the deterministically best option. In reality, today even the most powerful machine is very far from being able to do so, even though, in recent years, technology has provided us with sufficient computing power as to equip a

computer with such "deterministic depth" that, relying only on brute force, this machine is able to beat the majority of human beings, but not the great masters. Recently, machines have become structurally superior to men in the game of chess, even succeeding in beating the world champion. It should be stressed that such result could be achieved only by complementing a remarkable computing capacity with softwares programmed on the basis of the best choice strategies. In our language, this means to couple a powerful logical mind with an enhanced analogical mind.

[36] The first computer ever to achieve the speed of one petaflop (i.e. 10^{15} operations per second) was the MDGrape-3 developed at the *Riken Institute* in Yokohama.

[37] *The Dartmouth conference.* Artificial intelligence, at least under this label, was officially born in 1956. In 1955, the University of Dartmouth (New Hampshire) was requested to provide research funds for a seminar to be held the following summer. The document, which was signed by John McCarthy, Marvin Minsky, Nathaniel Rochester and Claude Shannon, is where the term "artificial intelligence" was used for the first time. This term was coined to refer to all those research activities which build on the conjecture that, in principle, "every aspect of learning or any other feature of intelligence can be so precisely described that a machine can be made to simulate it". And more than that, the proposal includes a few outlines for projects revealing how the birth of AI was marked by far-sightedness and optimism; the authors identified several areas of possible interest including the study of abstraction, the link between randomness and creativity, self-improvement, the use of language, the contribution of neural networks to the study of concept formation, a reliable system to evaluate the performance of a given calculation. The seminar set an agenda for the following years which may be perfectly summed up in the prophetic words concluding the proposal that was submitted to the Dartmouth College: "for the present purpose the artificial intelligence problem is taken to be that of making a machine behave in ways that would be called intelligent if a human were so behaving". The rest, as they say, is history: the first seminary on artificial intelligence was held in the summer of 1956 and it was attended by prominent scholars such as Ray Solomonoff, Oliver Selfridge, Artur Samuel, Trenchard More, and, finally Herbert Simon and Allen Newell, who, precisely in the year 1956, had completed the Logic Theorist, namely a program able to prove

theorems from Bertrand Russell's Principia. The conference became the opportunity for many to share ideas, research projects and, perhaps most importantly, a general feeling of confidence and optimism towards the rapid development of computer science, both on the hardware and software side. Not surprisingly, AI soon became part of the emerging "cognitive sciences", taking a leading role for a few decades. In 2006, the community of scholars in the discipline joined in Dartmouth to celebrate its fiftieth birthday attending a conference where both new researchers and experts were asked to strike a balance of the first fifty years and to communicate their vision of the next fifty. Five scholars who had also attended the 1956 seminar were the "spiritual mentors"of the transition from the first to the second fifty years of AI, namely: John McCarthy, Marvin Minsky, Oliver Selfridge, Ray Solomonoff e Trenchard More.

[38]*Strong artificial intelligence and weak artificial intelligence.* By artificial intelligence, we refer to the scientific discipline which takes as investigation criteria the same mechanisms used by the human mind-brain (such as language, perception, problem solving, decisions, consciousness, self-consciousness)and tries to reproduce them. At a philosophical level, the field of artificial intelligence is divided into strong and weak. Weak AI maintains that a suitably programmed computer can only simulate human cognitive processes just as it can simulate a weather event behaviour (the simulation of a storm, however accurate, is still a simulation). According to an advocate of this approach, a computer can at best mimic the behaviour of a professional chess player: claiming that it "thinks" about chess is like arguing that unicellular organisms "think" about protein synthesis. Thus, machines would have no real intentionality, rather they would merely follow a set of instructions as provided by a a program encoded within them. This thesis is supported by the idea that, in order to perform data processing, the computer merely associates the rules it is given with already existing symbols, without this implying any semantic understanding of the operations. Furthermore, a few scientists argue for the theoretical impossibility for a machine to solve those contradictions in which logic alone (i.e. for the time being, the only form of "reasoning" of computers") is, by definition, insufficient. On the contrary, supporters of strong AI claim the possibility that a suitably programmed computer can truly be equipped with genuine intelligence, not any less respectable than human intelligence. According to this view, mind can be regarded as the product of a complex set of computations that are

performed by the brain, hence the identification of all the relevant algorithms will suffice to reproduce it. Several recent studies in the field of cognitive sciences have taken this perspective as their underlying philosophy: in order to study in detail all intelligent systems, be these natural or artificial, one needs to consider the level of information processing and to investigate the algorithms and their implications.

[39]*White balance*. There is much more than a grain of truth in the adage that "the human body is the most amazing machine". Even though, on the one hand, our deductive abilities are, in some cases, merely a little more than decent and, on the other, our ability to discriminate sensory stimuli has been remarkably improved thanks to artificial tools, there are still situations in which human performance is superior to machine performance. One of such situations, namely white balance, has recently become topical as a result of the rapid spread of digital cameras and video cameras. This phenomenon may seem trivial: when exposed to sulight at noon time, or a neon lamp in a room, or the atmosphere of a cloudy day, our perceptual system is able to interpret the various color shades emitted by these different types of light sources as uniformly white; as we walk from a room lit by a lamp to an external field on a day of overcast skies, we are not aware of any color calibration ocurring in the reconstruction of the visual scene: we simply "see" the colors. The problem was already visible in traditional photography: when we develop the standard photgraphic film, a photo taken in winter will exhibit a dominant red component, while a picture of our garden will have a dominant blue component. In analogical terms, we tend to affirm that the former picture has "too warm" an effect, while the latter is characterized by "too cold" an effect. What is going on? The wonders of the human body tend to obscure a fundamental physical fact: the color of the light is constantly changing. Ths variation is descibed by the measure, in degrees Kelvin, of color "temperature" (since such measure is derived from the color spectrum emitted by a black body according to its temperature). For instance, throughout the day, the color temperature of sunlight changes ranging between 4500 and 12000 K, and varying from 000-3000 K at sunrise and sunset to 10000 K on an overcast day; camera flash has a color temperature of about 6000 K which is equal to that of sunlight at noon with a clear sky; a photographic lamp's color temperature instead is just 3500 K. The aforedescribed effect, which is detectable with traditional photography, is due to the fact that ordinary photographic films are calibrated for a color

temperature of about 5500 K: as we print photos that have been taken under different conditions, colors will appear "distorted". The digital revolution has both allowed us to overcome the limitations of photographic films and, at the same time, it has brought about the thorny problem of controlling the use of light within the camera itself. In our latest generation equipment, the white balance function precisely serves this purpose: once a "sample white" has been identified, then the system is able to adequately generate all the other colors by applying correction filters to remove unwanted color effects. This is why a manual white balance can be performed using a sheet of white paper which must be "read" by the camera within the chosen light situation: in very simple terms, it is as if we, while pointing at the sheet of paper, were saying to the camera "this is what white looks like in these conditions, so adjust accordingly". Despite the progresses made, ordinary devices perform well only under somewhat standard conditions, thus they are still far from human performances in terms of flexibility and reliability. The notion of filter, be it a physical filter (such as those employed in traditional photography) or a digital filter, undoubtedly offers a good key tothe understanding of this phenomenon also at a cognitive level, and this is primarily what makes it an interesting topic of discussion. A system's abilty to correctly visualize colors at different color temperatures of light is crucial to take the first step in th spiral of knowledge, namely the transition from Chaos to Signs, as well as a necessary condition to the successful execution of other, more complex tasks (perceptual or otherwise). Consider the difference in light color temperature between a sunny field of grass (6000 K) and the cool shadow under the trees on its borders (11000 K): when an organism such as ours moves back and forth through so different environments, the possibility of visual recognition strongly depends on the correct perception of colors. In a sophisticated organism, a set of correcting filters are applied to the "raw" information provided by the input system, this process rests on the action of models of reference which are undoubtedly triggered both by contextual perceptual factors (thus, a *bottom-up* mechanism) and by higher-level factors (hence, a *top-down* mechanism). The efficiency of this mechanism, which was honed by millennia of evolution as it is crucial to survival, enables us to recognize a certain body under different lighting conditions with nearly infallible reliability. There is some irony in the fact that a "metaphysical"concept such as identity depends, in its application, on so many sophisticated technological tricks.

[40]*Audio-video compression*. Let us consider the step taken by a system to complete the transition from Chaos to Signs along the the spiral of knowledge: whatever the details of this mechanism, it can be stated that, in a nutshell, the secret lies in the ability to select from a virtually infinite set of stimuli a finite (and possibly small) subset of them. The selected information will have to be meaningful, namely able to act as the basis for acquiring knowledge, concise, that is able to take fewer space than the whole input, rich, i.e. sufficiently complex as to derive all specifications relevant for processing from the input. The advent and spread of digital standards in the audio-video sphere, was accompanied by the appearance of various *codecs*, namely programs that code and decode data flows: a brief look at their operation allows us to observe our spiral of knowledge as well. Typically, there are two philosophies of data compression: without loss of data and with loss of data. The first approach certainly seems the better option: given the choice, what's better than an extremely faithful transcription? Contrary to appearances, however, the most useful, widely employed and interesting approach is the second one. In fact, the method of data compression that allows to preserve absolute fidelity to the original source is extremely costly in terms of compression size (and thus in terms of transmission and processing time). On the other hand, those system that tolerate a loss of data are more efficient in terms of the size of the information to be processed. Obviously, the crucial thing is that, if the *codec* works, there will be no loss of perceived quality after information compression. As an example, let us consider the compression on an audio track: an effective *codec* will first filter out those sounds that cannot be perceived by a human listener, thereby saving space; then, it will try to recognize *patterns* in the track as to reconstruct it as a sequence of identical "bundles" of sound. Of course, as the number of bits used for the representation is reduced, the noise will tend to increase: if the program functions properly, it will direct available resources to faithfully encode only the frequencies that the listener will be able to distinguish well. Similar considerations apply to video tracks: first, the information is compressed both "spatially" and "temporally", namely exploiting the fact that, on the one hand, neighbouring pixels in a given *frame* exhibit similar features and, on the other, consecutive *fames* have overlapping areas; thus, it will be the type of *codec* we decide to use to determine the information to privilege: if the subject is a football game, we'd probably like to have detailed movements sacrificing some color, whereas just the opposite will be true in the case of a program of art criticism. The file formats that are read by media players in our PC (i.e. Avi, Mp4, Asf, etc...) are "container" formats as they are a

means to transmit *streams* of different data types (which are differently compressed) such as video track, audio track and synchronization-related data. There is a twofold relationship between our cognitive systems and these recent digital technologies: on the one hand, tools such as lossy compression would not be possible if our perception of reality were different (for example, if it were more accurate); on the other hand, the mechanism underlying their operation is essentially based on the same philosophy underlying our own mechanisms. The transition from Chaos to Signs basically corresponds to the ability to fish for useful stimuli, in other words, the ability to identify cognitively salient information, i.e those information that "synthesize" the crucial features of the environment we are immersed in. The first of the filters we use along the path of information compression is undoubtedly our basic biological endowment: evolution has calibrated our senses so that certain portions of reality automatically appear as salient. On the other hand, there are undoubtedly higher-level contextual factors that, by triggering the relevant models of reference, further enhance our ability to selectively discriminate (and thus process) stimuli. If you walked into an empty classroom where an air conditioner is, you would immediately become aware of the noise; on the contrary, in the context of a university lecture, you probably wouldn't perceive any background noise to the voice of the professor: if the air condidioner were to suddenly switch off, you would find yourselves wondering whether you had already noticed that now-interrupted noise. There's no oddity in this: within the sonic chaos of the environment, your brain has simply decided to focus on a specific group of Signs.

[41]*Metacognition.* The concept of metacognition refers to the human ability to understand and reflect on one's own and others' mental states as well as one's own and others' perceptions, thereby managing to evaluate and predict one's own and others' behaviour. It is differentiated from cognition in that, immediately after identifying itself with mental states, metacognition detaches itself from such states to observe and process them, thereby creating a level outside that of "simple" cognition. Being endowed with such feature of intelligence gives rise to an essentially virtuous circle: learning leads to the knowledge of one's strategies of thinking which in turn leads to the enhancement of one's learning abilities. At a practical level, metacognition plays a fundamental role: it is now an established fact that the more a person is aware of how his mind operates and the more the person is able to exercise a control over his own cognitive processes, the more such individual will be capable of achieving

positive results in the application area. Inasmuch as it is nearly completely independent on the contents, several aspects of the mind are involved by metacognition, including: knowledge, control, awareness, the generalization of the same rules to different contexts. In consideration of the close link between metacognition and learning, it may be interesting to observe the drift of the implementation of this system within the educational domain: if it is true that learning to learn implies enhancing the awareness of one's own cognitive strategies and of their effective application, then what initiates the whole process might be the moment of motivation, or self-motivation, to perform those tasks that are aimed at one's evolution. Therefore, a possible solution for the education to "intelligence" may lie in proposing activities able to stimulate the motivation to learn and to expand the individual's interests and curiosity. Another twofold, and experimentally interesting, relationship is that which subsists between metacognition and models of attachment. On the one hand, those parents who exhibit well-developed metacognitive skills have a significant higher probability of raising self-confident children with respect to parents for whom such ability is low; on the other hand, those children who show a stable *pattern* of attachment will have fewer difficulties in developing a good metacognitive ability (i.e.positive affective experiences foster the development of reflective ability and a good reflective ability paves the way to positive affective experiences). Finally, in the therapeutic domain, the ability to create within oneself an observer that is "superior" (or external") to one's own immediate mental contents proves crucial in the treatment of certain particular diseases (obsession and autism, for example, seem to be closely related to a deficit in metacognitive skills). While learning is an ongoing, constant constrution, reconstruction and application of interpretation schemes to reality, the awareness of this process and the ability to evaluate it are essential to give meaning to experience and to apply those meanings to reality itself.

[42]A "quine" is a self-referential program that belongs to the descriptive domain, namely self-reference understood as property. Our research laboratory has developed self-referential modules which are able not only to describe themselves but also to evaluate their own behaviour. From a technical standpoint, one of the central ideas of our approach is to equip the software with a module that has a constant knowledge of the exact point in the procedure where the possible anomalous behaviour occurs. In very complex softwares, where procedures are recursively recalled, the solution to this problem is neither trivial

nor easy.

5. The Mechanism of Learning

Qutasa marigo samati velanozi ubet pirano. Co silagi limanisi anival zuramasita, dimoreta olimat felidi, gesifa menori. Bibasi? Nemaniri, nemaniri obaram tamasi.

That's crystal clear, right? Try to re-read the previous paragraph aloud (maybe with not too many people around...). What feeling does it give you? None, none at all? Then you are simple people. Does it convey any indefinite feeling of respect and take you back to some ritual atmosphere? Then, even if so far you haven't been aware of that, you have the privilege of directly discending from the people of Atlantis. Are you somewhat doubtful about it? Here are some additional evidence .Read it again within yourselves and focus your attention on those words that evoke the strongest feelings. Is it possible that absolutely meaningless words have nevertheless the power to provoke emotions? “Nemaniri, nemaniri obaram tamasi”, guys... The meaning may still escape some of you, nevertheless, almost everyone of you has the distinct feeling that there is some significance. Obviously, provided that the genes of our Atlantian ancestors are surviving inside you.

Let us help those who still fail to understand it and let us formulate some conjectures about the context of the sentence. It should be neither a declaration of love nor, for example, some store's inventory. It may have some reference to an invocation contained in a religious ritual. Or perhaps these are the final words of a verdict condemning some deplorable behaviour. There is something definitive in these words, something that will affect future years. At least, this is the opinion of the majority of people who engage in the effort of interpreting the meaning of the paragraph. Which is, obviously, meaningless.

Let us get quickly over the disappointment related to our Atlantian origins and focus on examining the path covered by our mind from the beginning of this chapter up to this point: a few lines, no more than a couple of minutes of time. We bump into a paragraph that is composed of words not belonging to any language we know. Nevertheless, more or less consciously, our attention is drawn by the regularity of the expressions and the compositions of words, thereby rendering plausible the existence of some underlying meanings. All these terms are two-syllable words composed of a consonant and a vowel (or alternatively, of a vowel and a consonant). It cannot be random: our mind expects some other intelligent system to underlie that paragraph. Now of course you know that such proposition has been purposely formulated to generate ambiguity, but the fact remains that there undoubtedly are some regularities in its construction. Can we really rule out the possibility that it might actually have a meaning in some language of the universe, be it past or future? If we received a message of this kind directly from space, most of us would deem the possibility that it had been sent by some form of extraterrestrial life at least worth of consideration.

For most people, that paragraph generates emotions, when it is "read aloud in one's own mind". And, for those people endowed with an amplified analogical component, such emotions can even be rather intense. At first, we find it hard to accept that a proposition whose meaning we fail to understand may nevertheless trigger some emotions. Hence, our logical component feels the need to understand the underlying cause. A bizarre hypothesis, i.e. that of the Atlantian origins, is suggested. Beware: you won't find it written anywhere that the proposition is written in the language of Atlantis. What you find is just that if someone feels any kind of emotions while reading such sentence, then he "has the privilege of directly discending from the people of Atlantis". What's more interesting is that if you read the paragraph over and over many time dwelling on the last phrase, "Nemaniri, nemaniri obaram tamasi", then it is far from impossible to conjecture that it might indeed mean something and that, perhaps it is really written in the language of Atlantis. Clearly, our personal beliefs about the actual existence of Atlantis must have heavily influenced the path taken by our mind. Some of you must have been immediately met by the doubt of being immersed in an ad-hoc constructed setting. And instead, some others must have had to wait until the very last phrase to be certain about it. Finally, a small number of you, but not equal to zero, must be deeming it possible that the paragraph really does possess a precise meaning and that it is a coded message for a circle of enlightened few. Who knows who's right in the end…

We conclude our path of analysis by investigating the various meanings that might be ascribed to the paragraph. It is interesting to remark that most people discard the hypothesis of the love message or that of a text related to some economic or daily activities. Many converge on the conjecture that it is a ritual or a judgement. However, the most intriguing element is probably the temporal perception that is triggered: a significant number of people tend to project it onto "something definitive" or anyway "something that will affect future years". Quite a result if we consider that the paragraph has no meaning whatsoever!

5.1 The "magic"

What is the "magic" that allows us to understand what we read, to recognize a person on the street or to come back home at night? Our reflections will build on the conviction that all our activities of understanding work in the same manner, regardless of the sensory organ involved. Therefore, the distinct acts of identifying an object or someone's voice, the taste of a given dish or the meaning of a proposition all follow the same path. But then, what is this this path[43]?

Our work team shares the belief that understanding stems from the simultaneous action of many different models of reference within our mind. The contemporary implementation of these schemes leads us to progressively filter Chaos until the emergence of Knowledge. Let us begin with an example. Slightly simplifying the problem, we examine what are the models of reference that you are certainly employing while reading these pages. The first one is the alphabet: we are using that set of signs that constitute what is commonly defined as "standard Western" (uppercase, lowercase, punctuation, numbers, etc...). At first glance, it might seem a trivial observation, but try to read a book in Chinese or in Sumerian... perhaps it's not that trivial, is it?

The second one is the language: we are writing in English but if now nous étions en train d'écrire en Français vous devriez changer vos models de référence thereby generating considerable problems of overlap to which you nevertheless would get used the second time and avec moins de problèmes que la première fois. A portion of our mind has operated a change in the scheme of reference switching to French, returning to English and switching to French again. A third model of reference that is undoubtedly implemented by everyone is reading a book's page. In fact, you are now accustomed to a certain font size: now, if for example we reduced the font size and then we restored the regular one you would have to change scheme of reference in order to keep on reading. Also in this case the subsequent times would require less effort. This three examples belong to the first-level models of reference, namely those that allow us to move from the apparent chaos (page written in Chinese) to values (words written in English) through the signs (standard Western alphabet).

The models of referece are relevant also at the level of the individual words and they operate on our reading in real time... for example, the fourth word in this paragraph is miswritten, some of you have certainly noticed the error and have immediately corrected it according to the word's clear meaning, however, most of you have even read it directly right thanks to the capacity of projection possessed by all the models of reference. As we ascend towards higher models of reference, we enounter another model of reference: you are reading the text contained within a divulgative book dealing with science. It would be a very different story if you were reading the exact same text in the latest edition of Batman or on an ancient papyrus found in a cave along the Jordan shore of the Dead Sea. Here we have just found a sixth model of reference thereby getting closer and closer to the concept of meaning: according to your own experience, each one of you has certainly given a different representation of the image of "the ancient papyrus in a cave along the Jordan shore of the Dead Sea". In the past, someone actually visited the Dead Sea, someone played a videogame containing an ancient papyrus, someone else saw some movie where certain useful information were found inside a cave. And so on... Each model of reference provides its own contribution to the understanding of what is being read. Certain models of reference are rather shared (the alphabet) and some others are heavily affected by subjective considerations (the videogame with the ancient papyrus). The more similar are the models of reference of the writer to those of the reader the more we can assert that the text has been truly comprehended and that a real passage of information and knowledge has occurred.

5.2 From Chaos to Signs

Let us imagine ourselves right in the middle of a city that speaks some unknown language: we can hear the sounds but we are not able to attach any meaning to them. Many went through the same experience in a foreign country, perhaps during a holiday in some Arabic-speaking nation. No matter how hard we strive, most of us will nevertheless be able to hear only meaningless sounds. However, a few days later, we start to isolate some regularities from the context; we are still far from attributing any meaning, but we are able to tell that it's Arabic and not Japanese, for instance. If we think about it, well, it is not a trivial matter at all: we fail to understand what is being said, nevertheless, we are able to identify the language with reasonable reliability. We only need to listen to a given language for a few hours to be thenceforth able to associate it with its respective linguistic stock, at least. We will probably struggle to distinguish Dutch from Swedish, but we won't confuse it with Chinese. And all this without understanding a syllable of what is being said. How is it possible?

The explanation lies in the fact that our mind is programmed to let regularities emerge from the apparent chaos, inasmuch as evolution provided us with well-functioning acoustic filters as well as with sophisticated language specializations. This process constitutes the first step in the path underlying learning:

Chaos => Signs => Values => Meanings => Understanding => Knowledge

But what does this first step precisely entail? Any intelligent system relates to the external world by means of sense organs. First, each sense receives data from the environment and it calibrates regardless of what it has to specifically look for. To calibrate means to specialize on the variability and to get prepared for the emergence of regularities. The first step is to store data in order to compare them. The data coming from a given sense are processed according to an initial resolution that will become increasingly higher at every iteration.

The reasons for this progression are probably multiple. The initial storage occurs in the area of short-term memory which is certainly more limited than that of long-term one. With every transfer, long-term memory becomes more accurate and therefore, short-term memory can focus on progressively refining the details. A second reason might be related to the memorization of relative rather than absolute data. At the first step there is no difference in the two pieces of data, but subsequently, there emerges the "zero" (i.e. the non-variable part) and thus the sense possesses the zero filter that it applies every time (thereby memorizing only the variable part). Related to the concept of zero are the notions of "minimum", "maximum" and "medium"; probably, we progressively move from the storage of absolute data (which is necessarily approximated for reasons of computational accuracy) to the storage of relative data with respect to basic models of reference that are memorized within our long-term memory. To associate a certain data set with a model means, in a sense, to give it meaning. The "piece of news" to be learnt is the residual data purified from the filters that were applied to the initial data. Let us analytically examine this path.

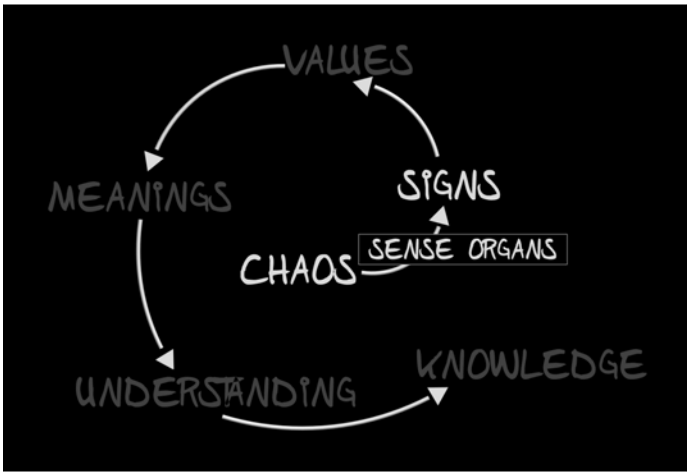

Fig. 5.1. : From Chaos to Signs.

The sense organ calibrates to the environment: it calculates the zero (non-variable part), it finds relative minimums and maximums (for each dimension), it tries to detect possible signs by searching for regularities in differences, it tests different sampling levels by modifying both the resolution (in space) and the frequency (in time) and finally, it selects the one that, on equal energy basis (overall number of steps), is able to maximize the differences between signs. Or, alternatively, in the case of a task to be performed, it chooses the sampling level that minimizes the energy required to execute said task. The more the sense organ is employed the greater the amount of energy that is assigned to it by the "energy distributor" (i.e. the supervisor responsible for determining the processing times). The more specialized sense is the more it is able to highlight differences (and to refine the calibration). The sense organ self-calibrates regardless of what it has to detect: if it has to look for something, then it will choose the most adequate sampling frequency (however, it is calibrated to the highest possible one). Reality is always more defined than the sense. At every iteration, our mind progressively learns more and more to the point that just any hint of the initial configuration is sufficient to trigger the recognition of the recognition of the sign. Most probably, this mechanism operates in all the five stages of the Spiral of Knowledge.

Let us take this discussion into the practice. A camera is the robotic equivalent of a human eye. Of course, there subsist significant differences in the respective constructions, but the underlying principles are nevertheless very similar. An image with a certain resolution is formed somewhere, in a given area of short-term memory ("neural" in the case of man and "elctronic" in the case of a robot). The flow of images is governed by a certain refresh frequency. We know that, in man, the image is two-dimensional, therefore we can represent it by means of a two-dimensional matrix. For example, in a 10000x10000 matrix there will be one hundred million elements, each characterized by a specific colour. Let us presume that our eye is able to distinguish one million different colours and let us also suppose that the matrix can be refreshed 30 times per second. This is a hypothetical estimation of the data potentially detectable by the human eye. We do not yet know what is the minimum information unit with which the human mind thinks, but, taking the bit as basic information unit, we may conjecture that approximately one hundred billion bits per second are transmitted from our eye to our brain. Two are the eyes, then we have the ears, nose, skin, tongue, etc... and we are restricting ourselves to the domain of external sensations. Obviously, we also have all the internal feelings (pain, pleasure, hunger, thirst, etc...) and those related to emotions (fear, happiness, distress, curiosity, etc...).

The amount of information that our senses might be able to transmit to the brain every second is relly huge. Nevertheless, we know that our mind examines only a small fraction of this flow. What and how many information does it take into consideration? The answer to this question is precisely in the first stage of the Spiral of Knowledge, namely,the one that allows us to move from Chaos to Signs. Now, let us return to the eye and the one hundred million bits of information per second. We can reasonably assume that, in a normal state of attention, our mind remarkably reduces the resolution, the frequency and the number of colours it is able to distinguish. The eye always maintains a potential of one hundred billion bits of information per second, but our mind only evaluates a far lower amount. Let us try to formulate some hypotheses on how many it does consider. With a 1000x1000 resolution, 5000 different colours and a test image 5 times per second, the overall amount of bits considered comes to 25 million[44]. With respect to 100 billion we have a simplification factor of 1 to 4000. Let us limit ourselves to consider the resolution: we move from one hundred million cells to one million. In other words, the information contained in 100 physical cells is synthesized in 1 cell.

It may be interesting to examine the process in its entirety. We have conjectured that our eye has a resolution in the order of 10000x10000 (10^4x10^4). It must be borne in mind that reality possesses a much higher resolution, at least ten billion larger. Let us imagine ourselves observing a one-square-meter picture with only one eye, at a distance such that our range of vision is completely occupied by the image of the picture. Most of us would find it difficult to notice any detail smaller than one millimeter (10^3x10^3). Some lucky ones, with fully functioning eyesight, a favourable context (a highly contrasted point on a uniform colour) and an adequate level of practice, would probably be able to distinguish a detail of one tenth of millimeter (10^4x10^4). If we only consider the atomic level, we know that reality has a 10^9x10^9 resolution, hence, our eyes should have a resolution of one hundred thousand times higher in order to be able to see the atoms. So, if we wanted to be able to observe the electrons, our eyes should possess a 10^{15}x10^{15} resolution, i.e.

ten billion times higher. As sophisticated as it might be, the optics of our eye is nevertheless able to perceive only a highly approximate level of the reality surrounding us. By the way, even if our sense organ were able to perceive reality in a higher definition (for instance, at the cellular level, equal to 10^6x10^6), our brain however would not have sufficient processing capacity to treat the data, therefore the eye should have to be endowed with an optics able to reduce the visual field as resolution increases. That is to say, it should be equipped with a zoom and not only with a focalization device.

Let us recapitulate. Reality has its own resolution level that we do not know yet, but we do know it must be at least of 10^{15}x10^{15}. In a perspective of semi-immortality, the level we need to have access to is the atomic one (with a 10^9x10^9 resolution): so, for example, we would be able to directly see and manipulate our DNA. With respect to this level, our eye performs an approximation by a factor of one hundred thousand, thereby making ten billion cells become one... definitely, too much of an approximation! That's why we have created machines that would help us access such levels of reality. As we said, our eye is able to offer a 10^4x10^4 resolution and our mind, in a normal state of attention, reduces it by a factor of ten: one hundred cells become one. In a condition of diminished attention, we have a further decrease in the resolution, of, say, another factor of ten. Thus, as we calmly walk along the seashore, all absorbed by our thoughts, our minds processes a limited amount of information coming from our eyes. The eye provides a 10000x10000 matrix, but the mind ompresses it into a 100x100 array: ten thousand cells become one. If our attention is drawn by something else, then a progressive increase in the resolution is initiated. If we happen to see a dark spot on the sand, we get worried about it being a stone we might stumble over, or even worse, which might cut our foot. Once the danger is gone, we go back to a low resolution; conversely, in case of doubt, we again increase the resolution with the aim of achieving a better understanding of the nature of the dark spot. This process is at the very basis of the passage from Chaos to Signs.

At the end of this first technical paragraph, we want to spend a few words on a methodological consideration before we proceed. For the sake of rigour, we should not speak of brain but rather of the nervous system in the broadest sense: in fact, part of the processing activity takes place also at peripheral level[45]. However, for discursive convenience, we will neglect this difference and when we refer to the mind we will intend it as the outcome of the processing performed not only by the brain but by the nervous system as a whole.

5.3 From Signs to Values

Let us continue along our path from Chaos to Knowledge by analyzing the second stage, namely, the one that will take us from Signs to Values. Recall the Spiral of Knowledge that, according to our work team, can be applied to any intelligent system (be it human, animal or artificial):

Chaos => **Signs => Values** => Meanings => Understanding => Knowledge

We have just seen that the previous stage is handled by those that are generally referred to as sense organs, namely, those operating units belonging to the system that is able to convey information from the outside world. The next step, i.e. that from Signs to Values, can be summarized in the process of allocation to a given class, that is, a sort of reduction of the (potentially infinite) multiplicity of the set of Signs to a set that can actually be used by the system. As an example, let us consider an alphabet. We are able to recognize several variants of a letter of the alphabet both in terms of font size and in terms of font style

AaΛAAAAĀ□

Our mind executes a classification process whereby it assigns the signs our eye processes to the "class of the As". But what does precisely characterize this process? Some specific models of reference are activated within our mind as they prepare the transition from Signs to Values. The most important among such models is certainly that of the "Western alphabet". If we observed the same sign engraved on a wooden board found somewhere in the Borneo forest, perhaps next to other signs of the kind

Γ∃Λ ∇□

probably we would be left with considerably uncertainty as to the transition from sign to value. Therefore, the model of reference "Western alphabet" that is activated by the context essentially lays out the 26 possible boxes within which I will tend to place whatever sign I might happen to encψnter. The term "whatever" is incorrect here: the sign "ψ" that we have just used in place of the letter "o" in the word "encounter" produces the automatic effect of activating the model of reference "novelty" upon which is based the hypothetical enlargement to 27 possible boxes. Here, there emerges learning: on the grounds of statistical and contextual considerations, our mind will evaluate whether to prepare itself for the twenty-seventh box or to consider the sign "□" as an error. Certainly, a second model of reference that is activated is that of the font. This page is written in a certain type of font, therefore **to change chara**cter **in an anomalous manner** (where "an**om**alous" stands for

statistically rare) implies a few difficulties **in the transit**ion from Signs to Values.

It is interesting to remark that reading an entire paragraph written in a different font is less tiring as it doesn't force us to continuously change the relevant model of reference. At this point of the paragraph, you should be able to read with far less effort since our mind has rapidly adapted to the new conditions!

Managing to read such a complex font as the one employed in the previous paragraph is quite a complicated endeavor and, if you think about it, it requires a non-trivial level of experience. In this example, there is another model of reference that certainly comes into play thereby significantly contributing to the transition from Signs to Values, namely, the model of reference of the English language. Now, if we wrote the next sentence in some unknown language then the experiment would become much more complicated... the proof of the pudding is in the eating. **R uyertgha poisjss ghhetrui oioipos kjdshusj laoik ksiuej fw jhsgbvxsa dfgg fgkvelk uytdes ldkid odsjare oatyzwa.** Interesting, isn'it it? And even more intriguing is the fact that such mechanism can be applied to anything we think or do. The Spiral of Knowledge rests on a continuous implementation of the models of reference automatically activated by the stimuli (both internal and external)that our senses register. From a computational point of view, the transition from Signs to Values implies the use of all the operators involved in the previous stage (i.e. memorization, comparison and measurement) plus a few other fundamental operators such as the operator "transformed" and the operator "allocation to a class".

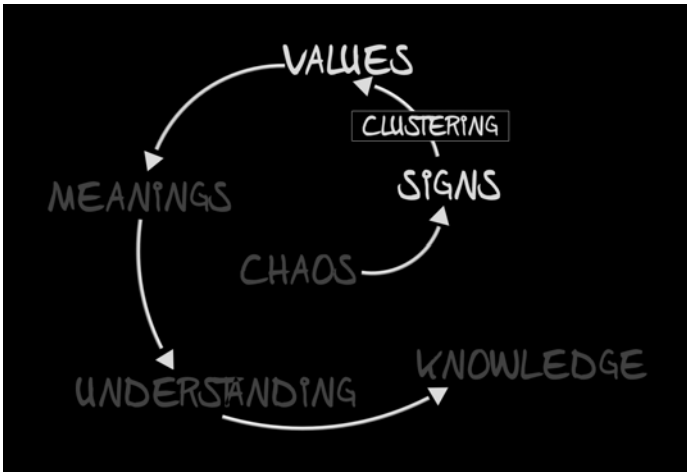

Fig. 5.2. From Signs to Values.

We move away from our pleasant walk along the seashore and we make our way into the forest on the outskirts of the beach. We pass through the path in the trees and shrubs. It is the reign of green in all its possible shades. At one point our attention is drawn by a few red dots suspended a few centimeters from the ground. We expect them to be fruits, but we are not really able to tell and so we get closer. Will they be tasty raspberries ready to eat or unripe blackberries? Or, perhaps, some poisonous berries? Our mind starts to examine the various conjectures on the basis of the signals it receives from our eyes. Is the fruit's surface smooth or granular? Do the fruits hang from the edges of small plants or do they grow on thorny bushes instead? We realize that on one side there are several brambles full of fruits, some red, other black and other else a bit black and a bit red. We are almost sure that they belong to the kind of fruit we know as blackberry. We ignore the red ones that had caught our attention, but we pick the black ones that are just ready to be tasted. Delicious. We move from Signs to Values.

5.4 From Values to Meanings

Now, let us continue along our path from Chaos to Knowledge by analyzing the next stage, namely, the one that will take us from Values to Meanings:

Chaos => Signs => **Values** => **Meanings** => Understanding => Knowledge

In this particular historical moment, the most important transition is undoubtedly that from Values to Meanings. If we manage to precisely identify (and, therefore, reproduce) it, what will be brought about is a crucial qualitative leap not only in the domain of artificial intelligence and software, but also in philosophy, psychology and, most probably, even in common sense and everyday life. From a technological standpoint, the first two transitions, i.e. those from Chaos to Signs and from Signs to Values, are allowing the development of utterly efficient artificial sense organs. Both universities and research laboratories are deeply involved, and often very successfully, in the field of visual, acoustic, tactile and olfactory recognition. Among the already available devices, we can mention micro-cameras that can recognize faces, scanners that translate a photocopied page into text, phone systems that identify the words, automatic dictation systems, systems for the environmental chemical analysis of pollution levels. At the present state of the art, the limitation of these technologies is that they fail to attribute a real meaning to what they "see" or "hear". The scanned page is not perfectly converted into text inasmuch as the software has no idea whatsoever of what it is reading. Automatic dictation systems often incur in transcription errors that a man (even if deaf or illeterate) would hardly commit. For the time being, we can say, simplifying a bit, that the most sophisticated current technology can deliver systems that are reliable at 90%. And today it is precisely in that missing 10% that the difference between a man and a machine is enclosed.

Note that in our exposition we deliberately haven't yet employed the term "understand" because comprehension is a subsequent stage that includes the concept of deduction. In this thid step, it is most correct to speak of "attributing meaning". We haven't yet arrived at the true understanding, but rather only at the representation. "Attributing meaning" signifies that there exists a space internal to the system where a model of the real outside world is represented. Moreover, it also implies that the system is able to assign some correspondence between what its senses perceive and the abstract elements the model is composed of. An investigation of this model immediately triggers two interesting questions. First, can this model develop autonomously or, at its birth, does it necessarily have to be activated, at least as far as its basic components are concerned, by an external system? Second, is the presence of several sense organs an essential condition for the existence of such model?

If we hypothesize the existence of a model of representation of reality that has been inserted by something (or by "Someone") external to the system itself, then we can ignore the question concerning the presence or not of several sense organs. Conversely, if we presume some kind of autonomous development, then we expect the presence of two or more distinct sense organs to be necessary as they all provide their own independent contribution to the formation of the model. It follows that the larger the number of sense organs we are endowed with the more complex and precise our representation of reality will become. No one yet has the definite answer to these questions. On the basis of our researches, we can only say that we deem it probable that, however, the presence of a multitude of sense organs allows a more efficient development of the system. We fail to make mono-sensory systems advance in a significant manner beyond the key threshold of 90%, since they need to be constantly "powered" from the outside, thus requiring a considerable effort. Vice versa, as soon as we con-

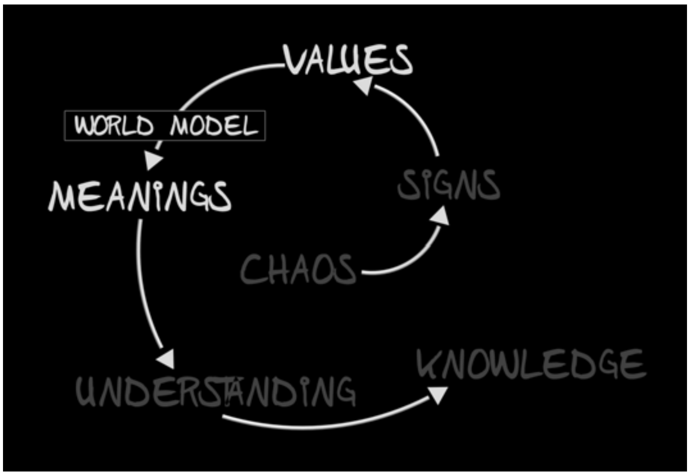

Fig. 5.3. From Values to Meanings.

sider a second sense operating on the same reality, performance dramatically improves[46].

We had our walk along the seashore and we have just enjoyed the taste of a dozen finely ripe blackberries. How long has it been since we last relished such a relaxing time and such an exquisite taste? A really good day. As we continue walking along the path into the woods, we come across a clearing. In the middle there is a small lake that is fed by the waters of a creek; the water seems just cool and refreshing. We get closer to reinvigorate ourselves and to drink a sip of water. Suddenly, we see some animals coming out of the bushes around the lake, running away and moving at full speed towards us. They must have been scared by something. For our own safety, we lurk behind a thick group of trees, standing ready to flee in our turn. Instinctively, we identify a tree right next to us which might easily serve as a temporary shelter. What has frightened those animals on the run? Now, in the distance, we catch a glimpse of a small group of growling dogs. It is better to stay away and wait until they are gone to chase someone else. We have just moved from Values to Meanings. How many times in the past has this transition from Values to Meanings saved our life? Probably, in this case, the dogs would have ignored us or we might however have been able to defend ourselves quite easily, but, as the saying goes, an ounce of prevention is worth a pound of cure.

5.5 From Meanings to Understanding

Now that the dogs are gone, we can safely return to our stream and finally manage to freshen up. We are really thirsty. As we approach the lake, we notice several animal skeletons near the lake's banks. How comes there are so many skeletons in such a small area? And why are they all so close to the water? It should be just the other way round: an animal dies because it's thirsty, not because it gets to drink. Unless... At this point, how many of you would be willing to drink the water of the lake with so many animal carcasses nearby? We chimps have never seen those Western movies where the water pools are poisoned by the token villain, nevertheless, despite being less intelligent than you humans, we are not completely stupid...

All in all, moving from Chaos to Values, passing through the Signs, is something within the reach of many intelligent systems, both artificial and natural. We can now regard it as deeply integrated into the body of knowledge of computer science and cognitive psychology. And, as we have seen in the previous paragraph, in the current period, researchers are primarily engaged in the task of investigating the transition from Values to Meanings. In sum, we can assert that sense organs allowed the emergence of Signs, the classification processes led to the emergence of Values and modelling external reality permits the

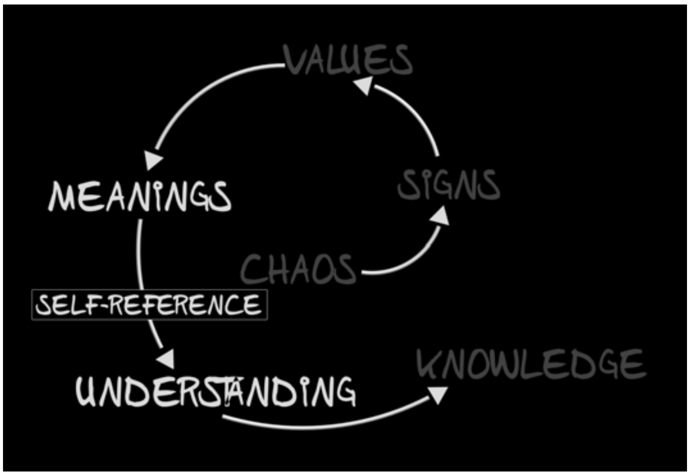

Fig. 5.4. From Meanings to Knowledge.

emergence of Meanings. Now, let us examine the next step, namely, the one that takes us from Meanings to Understanding, which corresponds to a giant leap in terms of intelligence of a system.

Chaos => Signs => Values => **Meanings => Understanding** => Knowledge

As it is often the case with a mechanism not yet fully understood, scientists and philosophers seem to have a strong preference for getting lost in long debates over the feasibility of certain objectives. And, while some are engaged in "proving" that it will never be possible to achieve these goals, others do achieve them. What does "understand" mean?

Recall that "to attribute meaning" does not yet mean "to understand". The attribution of meaning is basically a process of coupling a given value measured and perceived by the senses to a symbolic model of representation of reality, a process that conveys no information about the functioning of reality itself.

"To understand" means to infer and predict the functioning of reality by means of our representation model. If we see a ball being thrown against a window, we expect the glass to break; if we tell a person he won the first prize in a lottery, we expect him to have some reaction; by the same token, if we are traversing a crossing and we see a car coming up at high speed, we will take some precautions; if a colleague invites us for dinner, we will begin to foresee possible scenarios we might like to deal with or not. Let us examine how the mechanism of understanding originates.

A system can give a "point-to-point" response to a stimulus: as we are walking down the street, we see an object we like, we pick it up. Now, suppose that such object is inside a jewelry store. A reaction solely based on Meaning would lead us to just take the object: we would enter the store, we would grab it and we would leave. The owner, of course, would run after us and would try to stop us (in accordance with his model of "point-to-point reaction, he would probably resort to violence). In our turn, and again driven by our elementary behavioural patterns, we would react. Anticipating others' reaction thus represents a first step towards Understanding: it will drive us to camouflage ourselves, to train to get stronger and to minimize risk by operating at night and in group. But let us move further to a higher level. The dealer has a family, children and he purchased the object he is now trying to sell, working and taking risk: even if the store were completely unprotected and we were certain not to run any type of risks, still, most of the people we know would not embezzle the object.

What kind of cognitive miracle has occurred? Where did we leave those behaviours based on a "I like it, I take it" process? How many succeeding stratifications have been necessary to get to elaborate such a sophisticated cognitive process? For the time being, we resist the temptation to enter into philosophical speculations that would take us very far, and we remain in the computational domain. In order to accomplish the elaboration of such an evolved behaviour, it is necessary to have a model that examines the models, i.e. a model able to extract some general rules from the other models and which therefore reasons in a space of its own, distinct from the purely operational area. In other words, it is not sufficient to recursively mobilize the various models, what is needed here is precisely a meta-model. Are we getting closer to the activity of consciousness? Maybe... we computationally call it self-referential ability.

Before we embark on the analysis of the last stage of the spiral, we want to present a reflection. To how many life forms can we apply all that we have examined so far? We consider it quite reasonable that man is able to move from Chaos to Understanding (passing through Signs, Values and Meanings). At computational level, there are still some points that need to be clarified but, once we have agreed on the semantics of words, at an operational/functional level, it will be hard to find people who disagree with this framework. At least in Milan, rather than in New York or Paris, at least among people with a medium-high level of education and below sixty/seventy years of age.

These same individuals, if confronted with an ordered list of living forms which is arranged in ascending order according to the generally perceived level of intelligence, find it very hard to draw a line above which the Spiral of Knowledge cannot be applied[47]. Nearly everyone locates apes and dolphins above the line (recall that we are not arrived to Knowledge and we are still at the margins of Understanding). Nearly everyone agrees that also cats, dogs and horses operate according to this scheme. Most people tend to draw the line in the area between crows, bats, sharks, frogs and bees. Some even arrive at indicating the vegetable kingdom[48]. And not everyone leaves the final step in the evolutionary chain, i.e.. the leukocytes, off the list. In fact, if we analyze the behaviour of white blood cells from a functional point of view, it is difficult to deny that they do possess the ability to move from Chaos to Signs and from Signs to Values. We know that they are able to detect the enemy cells by means of their sense organs (whatever they be). Furthermore, we also know that they are even able to learn the characteristics of unknown intruders and therefore it is not unreasonable to suppose that they have a model of reference of the external world which is written somewhere within them. And so we have come to Meanings. Today, we possess a fairly good knowledge of the mechanism used, for instance by lymphocytes, to acquire the relevant information about a new antigen to produce the appropriate antibodies. We also know that this characteristic is preserved within the cell itself over time and then it is transferred to the daughter cells. At the moment, we cannot determine whether a cell somehow "understands" what it is doing, however, as far as the standpoint of the cell is concerned, we are fairly sure that it possesses a representation model of the external world and thus that, in our acceptation, it is able to "attribute meanings". We wouldn't be that surprised if one day we discovered that the cell also possesses some self-referential ability administered by some meta-model (obviously, from the point of view of the cell). Do you think it's impossible? Well, think about those bacteria that are able to live in extreme environmental conditions[49], with a life expectancy measurable in hundreds, and even thousands of years: are we really sure that all this might have occurred without any self-referential meta-model within such organisms? In our opinion, clearly, there is still a lot to be understood about this topic.

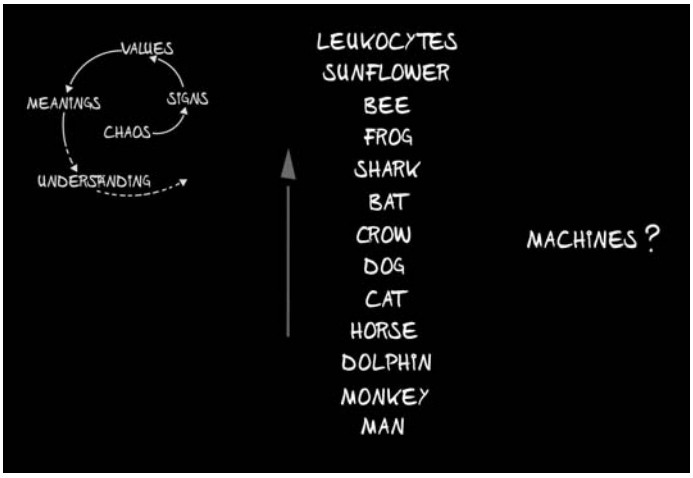

Fig. 5.5. To whom can't we apply the Spiral of Knowledge?

Let us leave the study of cells and bacteria to microbiologists and return to our Spiral of Knowledge and to the question of its applicability to the other life forms on Earth. If it is far from an obvious task to precisely identify at what point in the path of the spiral bacteria stop to proceed (assuming they do stop), imagine how complicated the task is when it comes to evolutionary superior life forms. Where will machines stop (assuming they will stop)?

5.6 From Understanding to Knowledge

If moving from Meanings to Knowledge represents a considerable leap in cognitive terms, the final transition is "The Transition" par excellence.

Chaos => Signs => Values => Meanings => **Understanding => Knowledge**

"To know" means to be able to get to the essence of things, to the ultimate laws of reality, to its intrinsic functioning. True Knowledge fundamentally is the Solution to the Game. Every time any one person comes to comprehend a primary and universal rule, such person moves nearer to Knowledge. We may define Knowledge as the thorough understanding of reality as a whole. From the standpoint of a system, Knowledge is a comprehensive, inner representation model of both the external reality and the internal reality. It follows that, in order to achieve Knowledge, the system must also come to understand itself.

Starting from Meanings, we can humbly and respectfully apply ourselves to the attempt of getting closer to the functioning of our mind, relying on the hope that the operators engaged in the first stages remain the same in the subsequent steps. By the same token, we also confide that the basic rules underlying the learning process equivalently apply to both man and any other living species. Perhaps, there will arise a few problems related to omplexity and successive stratifications but not to differences in the elements and operators involved. Finally, we have confidence in the possibility that our mind is essentially able to achieve the goal of comprehending itself, if not completely, at least to the extent of leading us to semi-immortality.

We have already ascertained that the presence of meta-model, i.e. of models of reference that are able to create and modify lower-level models, is a prerequisite for moving from Meanings to Knowledge. Perhaps most importantly, meta-models are able to operate in an abstract, completely symbolic space where the "senses" (whatever this term may mean at the higher levels of the spiral) interact with Meanings. At the present time, we still cannot identify what is necessary to achieve Knowledge. After all, a model that operates on meta-models (i.e. a meta-meta-model) in turn, itself belongs to the class of meta-models. Hence, we still find ourselves in the operational domain of recursive self-reference. In our opinion, some further development is required. Might that be meta-self-reference? We expect the Solution to be somewhere within us, written in a language we yet have to decode but which must necessarily be "simple", just as "simple" is the physical link between mass and energy and just as simple was achieving a better understanding of the reality surrounding us as a consequence of the discovery of the atomic dimension of matter.

43 *Knowing about knowledge*. The need to know about knowledge is a peculiar feauture of human nature. It seems difficult to overcome the circularity problem when we engage in the attempt of employing a given analytical tool to analyze such analytical tool itself because we feel bound to encounter the trap of self-referentiality. Therefore, it would seem that the only way to address this issue is to conceive circularity not as an insurmountable obstacle, but rather as a matter of fact, namely as a necessary and primitive component of the objective conditions of knowledge, which always entail a certain risk of "*looping*". From here, the birth of experimental epistemology whose central problems include the formulation of a natural history of knowledge and a natural construction of cognitive processes (thus, giving some hints about consciousness itself). Jean Piaget was one of the first experimental epistemiologists, and his teaching still accompanies the studies of his successors. The basic idea is that the relationship between action and knowledge is characterized by an unsolvable circularity: first, the decoding of an event is carried out on the basis of a set of elements belonging to a cognitive scheme that has already been acquired (assimilation process) and subsequently the cognitive structure is modified to take in new objects or previously unknown elements (accomodation process); hence, knowledge would be the circular succession of these two processes, where the rigid distinction between action and learning is blurred. Another remarkable contribution was provided by the cybernetic scientist Heinz von Foerster: relying on the epistemological novelties of his time, he aimed at developing a theory able to explain both the particular ability of some biological systems to store information and knowledge about themselves (i.e. self-reference), and the ability of a few systems to self-organize according to bottom-up principles (i.e. self-regulation). The "real", understood as the set of the objects we see and the events we witness, is not an objective fact, but a representation of relations: in a nutshell, the world would be a mere construction of the subject, where the experience of the individual becomes a cause, while reality becomes a consequence. The systems man are "observing", in the sense that they observe themselves: the observer is both the builder and the sorter of reality. Thus, on the one hand there arose second-order cybernetics: machines operate by progressively constructing a representation of the world that builds on the outcome of previous interactions with reality itself; on the other hand, there resulted a new approach to psychotherapy, moving towards a dynamic view of the patient-therapist relationship which now rests on a marked bi-directionality

of language and behaviours between the two subjects. Almost concurrently, physics and biology saw the birth of the concept of autopoiesis stemming from the mind of the researcher Humberto Maturana: cognition is a purely biological phenomenon and as such it can be investigated and understood only within that contex; learning, instead, is a progression which is undertaken by the organism through the process of self-organization. Each organism defines itself according to its internal organization, for it only has itself as a true reference, and it lets its behaviour depend on the surrounding environment which is solely perceived as something disquieting that leads it to self-reproduction. Contexts may change, but the underlying principle remains the same: reality is an arbitrary construction that is precisely based on an agreement about its characteristics among certain individuals or within a given community. This is why our hypothesis is that each system possesses several primitive realities, each endowed with its own models of reference and each resulting from a relationship between the inside and the outside of the system which it belongs to.

[44]At present, it is still difficult to provide any accurate estimate of these data. One of the most interesting researches in this direction has been carried out by a group of researchers at the *University of Pennsylvania*, under the coordination of dr. Vijay Balasubramanian, which focused on the analysis of the speed of data transmission within guinea pig retinas, which was estimated to be about 875Kbits per second. Assuming a multiplication factor of ten for the human eye, then we obtain a value of 8,75Mbits per second, which, in terms of order of magnitude, is not far from the aforementioned example.

[45] Very often, when we talk about the activities of our nervous system, we tend to refer only to the brain. Nevertheless, this is not entirely correct. In fact, notwithstanding its fundamental role, the brain is not the only actor on stage: for the sake of rigour, we have to remark that part of the processing activity also occurs at a peripheral level. This process is of the utmost importance to avoid an overload of (often redundant) information that the brain would otherwise be forced to handle incurring in very high energy and computational costs. For instance, let us consider vision. On average, there are about 126 million photo-receptors in the human retina, but only one million axons leaving the optic nerve. What does this mean? In short, we can stress that the huge process of selecting and filtering information already begins in the eye. Under particular circumstances, the brain is merely informed of what is going on, for instance, in

the case of the reflex arc: all the information is processed and transformed into motor commands at a local level in the spinal area. When our hand gets too close to a heat source or when we are pricked by a pin, the sensory information that is perceived by the cells reaches the bone where it is immediately encoded, and the output is relayed to the motor neurons which are responsible for making us retract our hand.

[46]*What is sound?* There are several reflections that, while simple and intuitive, are often neglected by researchers in their various scientific and philosophical investigations. Among these, the following one has always struck us in a particular fashion: if we hadn't been endowed with ears, how would we have ever been able to become aware of the existence of "sound"? Obviously, the exact same question may be asked about any other perception of ours, be it internal or external. This issue may be addressed from multiple perspectives. First of all, as it is well known, man can hear only a limited range of sounds: other life forms are far more sensitive than us, not to mention the machines we are able to construct. Is the experience of sound universal? Can plants hear sounds? Might there be some life forms able to "see" the sounds (perhaps by observing the sound waves)? Or perhaps, relying again on cognitive eccentricity (only with respect to our own perspective) able to "hear" the colors? The approach of the models of reference has proved very helpful in enabling us to find our way among these issues through the relativization of perception that is exclusively related to a system's ability to recognize it. However, at a scientific level, the central question is still unanswered: how many perceivable facets of reality are yet to be discovered? And at a philosophical/planning level: are all the sense organs to be interpreted only in light of a random evolutionary advantage or, within the perspective of the models of reference, at least one of them (perhaps internal, thus mental) is somehow "inevitable"? By using the term "inevitable", we certainly do not mean to dismiss the interpretative key offered by the process of natural selection among different biological systems. We are rather asking ourselves whether the existence of a Game played by any one Player in any one Universe structurally involves a sense (or at least a perception). This seems to be implied by the same concept of information: every information is information for someone, just like any stream of data is a motion from something to something else. If, as we expect, the mechanism of the models of reference is able to provide a sufficiently accurate explanation to all the manifestations of the real (thereby reducing the plurality of cognitive standpoints to

formal homogeneity), then it is be possible to hypothesize that at least one sense is inevitable in the sense explained above. If, on top of this, we add the perspective of the Game, thus of "purpose" and "project", such hypothesis becomes not only possible but even probable.

[47]*Cognitive supremacy.* It has been growing increasingly difficult to be certain about human cognitive uniqueness as compared to the other life forms. A number of different researches clearly show that man is simply more "complex" with respect to the other life forms, even those that are rather distant. For the time being, it still hasn't been possible to unmistakably identify any mental task that, in qualitative terms, can be performed by a man and not by, say, a cat. We can consider a man as quantitatively more "intelligent" than a cat, but also the cat is endowed with sense organs, various types of memory, language, learning ability, the capability of feeling emotions and, most probably, with some form of self-consciousness. Just as, under certain conditions, a cat can see better than a man so it wouldn't come as a surprise if we discovered that the cats possess some mental module superior to the human one (for instance, the spatial orientation module).

[48]*Plant Neurobiology.* Plants are not merely passive life forms subject to environmental forces. Among the studies on the topic, we may single out those carried out by Frantiaek Baluaka, Stefano Mancuso and Dieter Volkmann, which are explained in their book "Communication in Plants: Neuronal Aspects of Plant Life". The thesis upheld by the authors is that plants are dynamic and active organisms that are far more similar to animals than we are generally led to believe. In fact, the plant world is characterized by a complexity that was unknown until recent years: plant neurobiology is a very young research field, nevertheless it has been making great strides over the past few years. This discipline deals with the structure, function, deveopment, genetics, biochemistry, pharmacology and pathology of those systems linking the plant response to both internal and external stimuli. Not only are plants able to receive environmental signals, but they can also select, process and, finally, transmit them. Recent studies have shown that plant coloration would be a powerful means of communication. Typical autumn shades would not only result from the lack of clorophyll in the leaves: in fact, autumn is also the season when the aphids, namely insects that are particularly harmful to plants, lay their eggs. Therefore, the chromatic change would be intended to produce a signalling effect to the

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insects to "warn" them that the plant is chemically ready to defend itself from possible attacks. As Mancuso argues, the question of whether these abilities are to be regarded as signs of intelligence is a purely semantic problem. Finally, it should be borne in mind that, while plants seemingly correspond to slightly more than 5% of the taxonomy of the living world's diversity, the active principles of more than 95% of drugs are extracted from this small percentage. Hence, for the purpose of semi-immortality, advancing our knowledge in this field is more important than ever.

[49]Certain bacteria known as "extremophiles", such as *Deinococcus Radiodurans*, are able to live in the most extreme environmental conditions. In fact, there exist life forms capable of adapting to the depths of the oceans, with no contact with the sun, to temperatures exceeding 400 degrees or below -100 degrees, besides exhibiting a high tolerance to radiations that would destroy the genetic material of any other life form.

6. Self-reference

It's winter, somewhere in north-western Africa. An intense sirocco is blowing, making the day particularly hot. Before me, the long waves of the Atlantic Ocean rolling in. At my left, the first dunes of the Sahara desert and behind me, the red mountains of the Atlas. Last night it snowed on the highest peaks.

I am heading towards the boat, but today something is holding me to the shore. The wind is good, pretty strong, fickle. Funny. I cannot make up my mind. What is so unusual today?

The wind. I concentrate myself on the wind. It keeps on changing its direction, or, more precisely, it simultaneously blows from three different directions.

I can neatly perceive the smell of the mountains, of the desert and of the ocean. At the same time. It's a unique, wrapping sensation. And complex, extended.

The wind is predominantly coming from the south-east, but by paying attention you can clearly perceive also the wind from the west and the wind from the north-east, their three distinct smells and their three different temperatures. At times one prevails, at times another does, in a captivating alternation.

It is pure pleasure, both physical and mental.

After a few minutes, the area of my brain devoted to analytical reasoning begins to perform the task it was designed for: i.e. to enhance the level of consciousness.

I start to visualize the molecules of air, each with its specific velocity and temperature, which are alternatively fluctuating on the surface of my face and those that vibe to the olfactory receptors of my nose, carrying smells that are a few tens kilometers away.

In what area of my nose do I sense the smell of the snow? What area of my face is touched by the warm wind of the desert? And what by the humid air of the sea? According to what hierarchy is my brain decoding the signals and in what sequence is it storing them?

A few other minutes pass by and at a certain point my mind is captured by a new dimension. Time seems to almost stop. Everything is a little bit slower.

I look at my own image from a distance hard to measure, or rather I wouldn't describe it as an actual spatial distance.

I'm standing on the dark yellow sand right before the deep blue of the ocean, the lingering waves lap against my feet at a short distance from the whitened peaks of the red mountains.

And I look at myself while I try to ponder about the situation, at the risk of missing its incomparable beauty.

At one time, I am both in my mind thinking about the different degrees of humidity of the three winds and in my mind reasoning about my mind that reasons. How is that possible? What does it cause such effects on my brain? But, wait a second: what is happening again? Let us try to set some order.

If I remember correctly, this morning I was heading towards the coast. At a certain point, I interrupted my walk and stopped along the seashore after I had perceived a particularly intense sensation.

Then, an odd event occurred, I looked at myself right while, standing be-

fore the ocean, I was trying to analyze my feelings. And a few seconds ago, I even started to look at myself while I was looking at myself.

Not to mention the fact that, in reality, I am only writing words that describe what happened that day.

And not to mention either the fact that, in reality, you are only reading the words I have written, thereby visualizing the situation within your mind.

Welcome to the world of self-reference (and to the world of recursive self-reference and, perhaps, also to that of meta-self-reference).

6.1 Self-reference as an attribute and an ability

Let us start our path towards the understanding of self-reference by briefly examining it as an attribute. When can a system be qualified as self-referential? A system can be defined self-referential when at least one of its elements refers to the system itself. While the definition is fairly intuitive, its comprehension is far from straightforward. Let us immediately present three examples. Now you will read the proposition "this book is written in English". Letting aside the obvious jokes, henceforth we can assert that the book is partly self-referential inasmuch as it includes at least one proposition referring to the book itself. Let us operate a further simplification by considering the following simple proposition: "this sentence contains five words". This is a typical self-referential proposition, its prmary meaning (that is given by the verb) takes as its subject precisely the proposition itself. Let us proceed along our path, we encounter an anomaly when we take into consideration the simple proposition "this sentence is false". Not too much

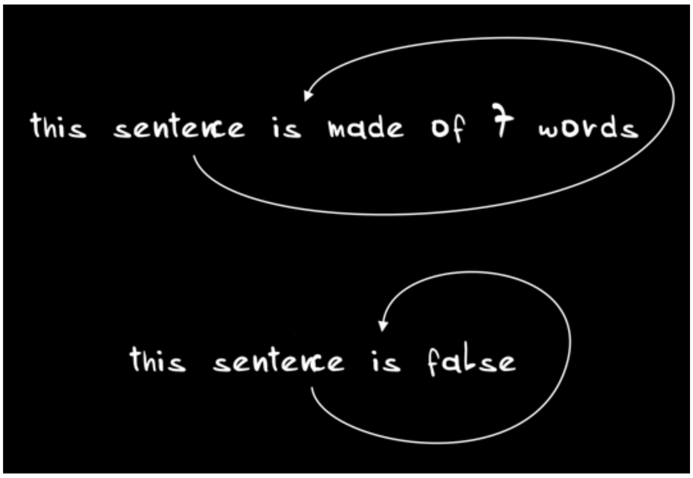

Fig. 6.1. Examples of self-referential statements.

effort is required to understand the paradox contained in this sentence and the vast array of its intricate logical implications. If it is false, then it follows that it is not true that the sentence is false, therefore the sentence is true, but if it is true, then it follows that the sentence is false... is there any remedy for a severe headache available? Producing self-referential mechanisms by means of language is fairly uncomplicated for a book is very well suited to talk about itself. Many authors often employ self-reference as a narrative style thereby enabling the reader to experience the story both inside the plot and from the outside, namely, from the perspective of the writer. This momentary rise in level allowing us to consider the "plot as a plot" generally produces a pleasant effect on our mind.

Depending on the reference domain of the system under consideration, we will be able to observe a variety of ways in which self-reference might manifest itself. For instance, besides writers, many artists exploit self-referential hints in their works. Probably, we can identify the most renowned "self-referential" painter in Mauritius Cornelius Escher, nevertheless many other artists have drawn inspiration from the same concepts, most notably René Magritte. Cinema, just like literature, is very well suited to use the self-referential mechanism and many directors have recurred to it in an especially effective manner (in particular, we like to mention Federico Fellini).

If we confine ourselves to the domain of a tale, a painting or a movie, self-reference is merely an attribute, but when we extend such concept to an active system (i.e. one that is able to interact with itself) then self-reference becomes an ability. Hence, we say that a system posseses self-referential abilities when at least one of its elements is able to modify the system itself. In order to accomplish this result, the system needs to be able first, to realize what it is doing, second, to evaluate the efficiency of its own behaviour against specific criteria of efficiency and third, to act accordingly. Let us examine an example applied to man and the normal, daily activity of writing. The first step consists in becoming aware of what is happening, namely, possessing the ability to devote a part of our mind to the control of the sentences we are writing. In other words, a portion of our conscious "I" is dedicated to "observing ourselves while we are writing". It might be useful to reflect on the fact that this alone implicitly entails significant advantages. The first one is to decrease the risk of neglecting the context and thus to protect ourselves from grammatical errors. After all, no one likes to leave one's house in rags, or with one's hair messed up (unless one has deliberately decided to turn up in this fashion), and that is why we check ourselves at the mirror. The next step is to evaluate, i.e. to be able to determine what is right and what is wrong. It is not straightforward (and it is often contoversial), nevertheless it is far from impossible to judge whether a book or an article was well or poorly written. On the other hand, no one likes to walk around with a greasy spot on one's clothes, since it is not difficult to recognize that a greasy spot on your clothes is generally

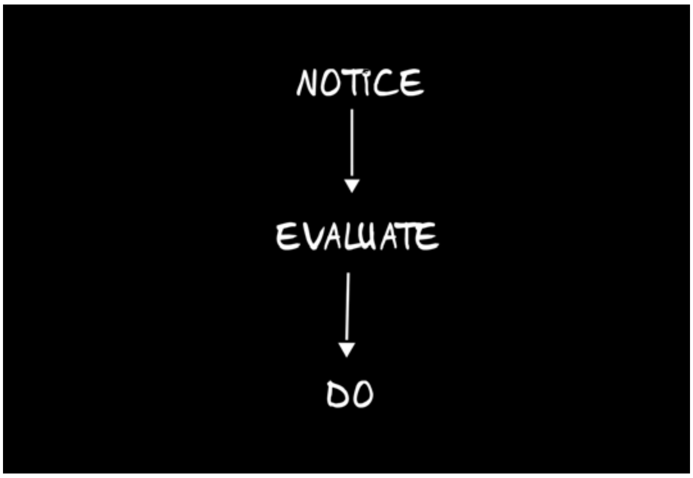

Fig. 6.2. The three phases of self-reference.

"wrong"(and what about the colour? Is a canary yellow suit "wrong"?). Finally, there is the action, namely, the use of the known technical instruments aiming at continuously correcting and refining what we are doing. For example, to learn grammar properly, to practice our writing skills, to read a lot, etc... it is quite intuitive that the first step plays the pivotal role in this process: if we weren't able to realize what is going on we wouldn't be able to trigger the next two steps.

The difference between observing the ordinary cat crossing the street and observing ourselves while we are writing "merely" consists in the fact that we are looking at ourselves and not at any external object. But external to what? To our body? To our mind? To a portion of our mind? Let us leave the domain of actions and move on to the field of thoughts. Within our mind there surely lies a sense that is able to see ourselves as we carry on any action, namely, the fundamental basis to modulate our behaviours. However, most probably, there also exists a sense (and perhaps the same one) that is able to see our thoughts, namely, the fundamental basis to modulate our own thoughts themselves. We have arrived at the very root of self-reference. In computational terms, we are simply referring to the case of a software that observes, judges and modifies the behaviour of another software. In line with our approach, if the two softwares operate in the same machine and if they perform their computations in parallel and independently on one another, we will assert that the system does possess self-referential abilities. It is precisely this ability that probably allows a man to be aware of being a man and that in the future will enable a machine to be aware of being a machine.

Therefore, following a systemic approach similar to the one used for the Spiral of Knowledge, we expect consciousness to be nothing but a very sophisticated sense organ. If we compare it to the sense of sight, we might say that consciousness corresponds to the eye, whereas the activity of consciousness corresponds to sight. The eye is an external sense organ, while consciousness is an internal sense organ, as language. Hence, just like we expect the discovery of the genes governing the formation of language, so we we also expect the identification of the genes governing the formation of consciousness. Continuing the analogy, just like the development of language is affected by experience, so will be the development of consciousness. Finally, just like we expect language to be the result of the application of numerous, partly inherited and partly acquired, models of reference, so we expect consciousness to stem from numerous, partly inherited and partly acquired, models of reference, some of which will nearly certainly possess self-referential attributes.

6.2 Recursive self-reference

If the same criteria of "observing", "evaluating"and "acting" are applied also to modulate the behaviour of the same software that is precisely assigned the task of "observing", "evaluating"and "acting", we will be confronted with the interesting case of recursive self-reference. We consider it likely that our mind's self-referential module is also able to observe itself, perhaps displaying some operational limits in terms of change capabilities, but nevertheless preserving the possibility of creating a visual point that is able to observe itself. Our researches concerning the ability to train and strenghten one person's self-referential ability rest on the possibility of being able to interact with the self-referential module itself. We do not precisely know what truly happens in practice (perhaps another sense is created or a dormant sense is activated), however we deem it probable that a necessary step for the enhancement of our self-referential abilities is a recursive application of the ability itself.

The concept of recursive self-reference is extremely powerful, though not always immediately intuitive. Has it ever happened to you to "dream of dreaming"? It is not a common event, but many persons nevertheless claim to have undergone this experience at least once. At times, we dream of living in a house with features that somehow relate to our childhood, or of flying, or about our parents, etc... At times, regardless of the script our mind has decided to present to us on that particular night, we are aware of dreaming, whereas at some other times the dream is so sharp and realistic that we do not relize we are in a dream. An undoubtedly bizarre script would be to dream of dreaming and the zenith of oddity would imply the first dream to be very realistic and the second dream to be aware of dreaming. If you are struggling to follow this argument, do not dishearten yourselves: it is mostly a problem of words because the concept itself is not complicated, although perhaps unusual.

Let us recapitulate. We have peacefully fallen asleep in our bed and, towards the morning, we enter the last sleep cycle.

For example, we are dreaming of the hotel room we were staying a few days ago: with us there is a person we know very well and with whom we are enjoying a particularly interesting conversation. The dream is as realistic as it is deep, thus we are totally immersed in the dream reality: that is what constitutes the only perceived reality. At a certain point, the dream makes us fall asleep and have a pleasant dream, what one is up to you to decide. We know we are dreaming the second dream, but we don't know we are dreaming the first one. Perhaps, we have some fun directing the dream along a favourable path (as we would do in a conscious first-level dream) and we let it flow until the moment we wake up. Of course, we wake up from the second dream, but not from the first one. A short while later, in the real world, the alarm clock rings thereby wakening us up also from the first dream with the clear memory of having just woken up from the second one. Here an example of recursive dream which is really close to the concept of recursive self-reference.

The first mathematician ever to employ, in a certain sense, the concept of recursive self-reference was Jakob Bernoulli in the fourth part of his “Ars Conjectandi”, posthumously published in 1713. In the demonstration of the law of large numbers (i.e. the fundamental theorem of probability calculus) he invoked the same concept of probability to define it, thereby resorting to a recursive self-referential procedure[50]. It is interesting to notice that this theorem stemmed from the work of Gottfried Leibniz (of whom Jakob Bernoulli was a fervent admirer) and it is connected to the families of central limit theorems, namely the theoretical basis of the normal distribution curve[51] (first studied by Carl Friedrich Gauss), i.e. the function that most accurately describes the behaviours of the biological world. Around the year 1930, Alan Turing himself addressed the question of developing a proof of the central limit theorem[52]. The “Ars Conjectandi” contains several other concepts that were later developed by many researchers in the field of artificial intelligence. Notably among the others we should mention Ada Lovelace, a great admirer of Charles Babbage, who, around the year 1840, formulated a particularly brilliant algorithm to generate a numerical sequence precisely known as "Bernoulli numbers"[53].

In the early years of the Twentieth century, Bertrand Russell devoted considerable attention to the class of self-referential paradoxes that can be related to the proposition "this sentence is false". In logic, this proposition is known as the Liar Paradox and it underlies the central problem of self-reference: can a system wholly describe itself? In his 1931 paper "On formally undecidable propositions of Principia Mathematica and related systems"[54] Kurt Goedel demonstrated that such result is unattainable. This proof is known as Goedel's theorem or incompleteness theorem. From the standpoint of artificial intelligence (but of mathematics, philosophy and psychology as well) the implications of this theorem are monumental and they can be synthesized in the concept that within any formal system there will always exist a few non-provable statements. In other words, a system will never be able to give a comprehensive definition of itself, but it will rather need something that is exogenous to the system in order to be wholly defined. In turn, such defining system will not be able to give a comprehensive definition of itself, but it will rather need another system, etc... Besides Kurt Goedel many other scientists have dealt with this issue along similar lines, most notablyAlfred Tarski (i.e. one of the leading modern experts on the concept of truth) and Alonzo Church (i.e. a forerunner of functional programming languages such as Lisp[55]).

Why is this such an important topic? In accordance with Douglas Hofstadter and Heinz von Foerster, we believe it constitutes one of the essential keys to understand the functioning of the human mind. The implications are both of a computational and a theoretical nature. We ask the readers who have never dealt with this issue before to be patient since we regard this step as extremely important, in this moment perhaps the most important of all. The main immediate reward for the effort put in achieving a flawless understanding of the topic will be the possibility of recovering from certain diseases by simply using our mind. And the main secondary reward will be to be able to equip those machines that will help us to attain semi-immortality with activity of consciousness. Understanding self-reference, and recursive self-reference in particular, in its essence is not an easy task. Just as it is not a piece of cake to understand Goedel 's incompleteness theorem and its extensions to Tarski's partial truths. Now, let us leave aside all these names and their historical evolution: those who might wish to deepen their knowledge of the subject will be able to do so starting from the second of the 23 problems presented by David Hilbert on August 8, 1900[56]. Let us not concern ourselves with mathematical formalisms and unusual terms either, trying to get to the essence of the topic. If you have never dealt with this issue before, you will take some time to understand it , not much because it is particularly difficult, but rather because, despite being it often a part of our everyday experience, we generally do not pay enough attention.

At the beginning of this chapter, we have introduced self-reference through the detailed description of a real-life event: it was December 31, 1999 and we were on the beach of the bay of Agadir, in southern Morocco. It might be useful to read it again. Furthermore, at the beginning of this paragraph, we have reported another example, again taken from real-life experiences, namely, that of "dreaming of dreaming". Now we will illustrate a final example that dates back to the earliest years of our research laboratory. The year 1984 saw one of the first economically "interesting" repercussions of our researches with the development of a forecasting software for a major food company[57]. The core of the software was a module able to modify itself: that is to say, the software could directly change the instructions that made it up. Therefore, it can be said that such software possessed full-fledged self-referential abilities. Of course, the one thing a computer does is to follow the set of instructions of the program that has been stored in its memory; but if, on the basis of specific criteria, some of these instructions modify the program itself, then it follows that the program changes over time. And if the program is also able to alter the part of the program that is designed to change the program itself, then we can justifiably assert that the software possesses self-referential abilities. Overridding any possible quibbles, we think that this example might result interesting and understandable not only to computer programmers.

This last example of the program able to modify itself brings us considerably closer to the essence of the issue under consideration. Among the most interesting reflections that might arise is there undoubtedly is the question of the extent to which a program can actually modify itself. It is another way to rephrase the crucial question of Goedel's theorem: can a program totally modify itself or will there always be some parts that can never be changed? The answer is not straightforward. We may assert that the following fact can be easily verified: a program can uncomplicatedly modify any of its parts other than the one devoted to alter the program itself[58]. At the moment when the program changes that part, it tends to become unstable and it crashes. There is only one way to try to overcome this problem, i.e. duplicating the modification module and making one of the two modules be modified by the other one. So, problem solved? Unfortunately, not. The trick of duplicating the model is very efficient in terms of functionality and it significantly reduces the problem, but such problem is shifted rather than completely solved. In fact, this solution shifts it to a third module that will necessarily be responsible for deciding which of the two modules must operate at any given time. Have you lost the thread of the discussion? Let us try again to take it into practice. If we insist so much on this point is only because, as repeatedly stated earlier, we consider the study of self-reference as one of the fundamental steps to achieve semi-immortality.

We are designing a space probe to be launched to Mars with the task of investigating the planet's surface. Our goal is to make it work for the longest time possible. Let us assume that a colleague of ours has brilliantly solved the problem of power supply thereby rendering available a virtually unlimited source of energy (for instance, solar energy). We will “only” have to worry about making it operate for as long as possible. A careful design will provide for the duplication of all the probe components that might get damaged and for some self-repair ability. The duplication of components will allow the probe to basically maintain its essential functionalities in case of failure, while the self-repair ability will enable it to limit the time of exposure to the risk that the spare component breaks without the possibility of replacing it in turn. This approach leads to a considerable increase in efficiency, yet it does not eliminate all the risks that our probe becomes unusable at the first damage. At this point, what is the most critical component? The one that is responsible for deciding what components, among the many available ones, must be operative at any given time, i.e. the one that, in the event of failure, activates the substitute component. If we are any intelligent and smart, then we will try to duplicate such component as well. Problem solved? Almost, but not quite. At this point, the only truly critical component is the one that controls the two components controlling all the other ones. It is an excellent design, but it doesn't completely remove the possibility that the probe halts at the first failure. Thinking in terms of probabilities we have extended the life span of our probe by several orders of magnitude, nevertheless we haven't come to an indefinite extension. Perhaps, we have moved from a few days to tens of years of life (and this is already a remarkable result), but we cannot qualify it as semi-immortal. Are you starting to grasp the significance of self-reference?

A good design must be complemented with the realization of a good self-repair module. Such module needs to include all the relevant information concerning the structure of our probe and, of course, it has to be able of repairing itself. In this case, self-reference operates at two distinct levels, both in terms of the design's appropriateness (it is not possible to completely eliminate critical components) and in terms of self-repair ability (in order to be able to repair itself, the probe must be self-referent toward itself).

6.3 Meta-self-reference

Meta-self-reference is quite a terra incognita. By meta-self-reference we mean a system's ability to self-generate the modules responsible for self-reference. As far as our mind is concerned, if recursive self-reference is somehow connected to the conscious "I", then the presence of the "self-reference module" implies the possibility of generating conscious "Is" at will. Our researches in the domain of multiple personality disorders and the various forms of schizophrenia (for instance, the less severe forms, i.e. those that most of us are confronted with on a daily basis) do not exclude the possibility that within our mind there exists a module generator of conscious "Is"[59]. Continuing the analogy with the other sense organs, it can be said that just as we are endowed with two eyes we might equivalently have two consciousnesses. From a computational point of view, and at this stage of knowledge, we can only formulate a few hypotheses. Let us try to follow what might be a feasible route. The instructions to construct both our body (i.e. the hardware) and our mind (i.e.the software) are inscribed in DNA. Within our mind there exists a module able to observe and modify, at least in part, the activity of mind itself (i.e. self-reference). At this point, it is possible to conjecture the presence of an additional module responsible for handling the conscious "Is" (i.e. meta-self reference). The function of this module might be to repair and modify the consciousness module should any problem occur. Theoretically speaking, there might be multiple levels on this path, hence we might also hypothesize the existence of recursive meta-self-reference. Nevertheless. It is reasonable to assume that the path terminates at some point, namely, with the unchangeable "ultimate module" of which it will be impossible to have any internal perception. And that is precisely the moment when the machines will once again be irreplaceable instruments: at the end of the day, we can see our own eyes only by resorting to the use of a mirror.

[50] *Self-reference and recursion in mathematics*. Probability is the prediction that a given event will occur, however, Jakob Bernoulli's law of large numbers, i.e. the funadamental theorem in probability, does not state that, as the number of trials increases, this will tend to coincide with the actually observed frequency, but rather that the probability that the observed frequency deviates from the theoretical probability will tend to zero. Bernoulli resorted to the concept of probability to define it, through a self-referential and recursive procedure. But what does this famous law implies in practice? Let us assume we want to verify whether a die is loaded such that the number two appears more often than all the others. Hence, we start with a series of die rolls and we will write 1 when the die shows two and 0 when it shows any other number: 1,0,0,0,1,0,0,0,1,0,0,1,0,0,1, etc… We therefore obtain an estimate of the probability of getting the number two when the die is rolled, which is calculated by adding up the numbers in our series and then dividing the sum by the number of rolls: in our case, the estimate equals 5/15, thus 1/3. And this is where the law enters the picture: it states that as the the number of repetitions used to calculate the estimate, grows, this will move closer and closer to the actual probability of the event, i.e. p: since the probability of getting two is 1/3 which is far higher than the probability equal to 1/6 (which would be guaranteed by an unloaded die), we can be certain that the die we are rolling is loaded. But how much certain? By the law, the degree of certainty depends on the number of trials: 15 is a very small number, but if the trials were 10.000, we could be fairly certain; if they were 100.000 we would be even more certain, and so on. The succesful use of self-reference in demonstrations is not confined to this case. For example, consider the proof of the contradictoriness of classical set theory. In fact, the so called "axiom of comprehension" guarantees that, given any specific property, there will exist a set containing all the elements that satisfy said property. Bertrand Russell has shown that this leads to paradoxical outcomes characterized by particular self-referential properties, such as "being the set of all sets that do not contain themselves as members". A few years later, Alfred Tarski showed that a language cannot refer to its own semantics (in particular, it cannot define its own truth predicate) as, otherwise, the liar paradox (i.e. "this sentence is false") would occur. On the other hand, in formal contexts, recursion is an equally appreciated feature. Typically, some functions are recursively defined inasmuch as the definition refers to the function itself. For instance, the factorial function can be recursively defined as follows: fact(n)

= (base case) 1, if n = 0, (recursive clause)n x fact(n-1), in all other cases. Tarski's work on truth in formal languages is another famous example of recursion: the first step consists in defining truth for the atomic formulas of the language, then, truth is fixed by means of specific clauses for all other formulas obtained from atomic formulas by composition, consistently with the truth conditions of the latter. For instance, let P, Q and Z be the basic formulas of our language, & ("and")the only logical connective, and let us assume P and Q are true while Z is false. Now, let us informally employ the notion of complexity, letting P be a formula of complexity 1, P & Q a formula of complexity 2, (P & Q) & Z a formula of complexity 3 and so on. Starting from the truth of the atomic formulas, which is assumed to be known, Tarski showed us that the formulas of the type x & y (complexity 2) are true if and only if x is true (complexity 1) and y is true (complexity 1). By the same token, P & Z (complexity 2) is true if and only if P (complexity 1) is true and Z (complexity 1) is true. But we know that Z is false, then P & Z is false. This procedure is totally general: in fact, truth for a formula of complexity 4 will be defined relying on the formulas of complexity 3 which compose it; thus, the truth of the latter will be evaluated at the level of complexity 2, and finally we will come to check the atomic formulas. Therefore, it is possible to define truth for an infinite number of formulas, starting from a finite set of rules. Notwithstanding its relative banality, our example is however able to clearly show the power of this concept.

[51] *The normal distribution curve*. For a long time, there had been a clear boundary separating mathematics from the physical reality. Beyond any doubt, Carl Friedrich Gauss should be singled out among those who have provided crucial efforts to overcome this boundary, and, in particular, one function has critically contributed to such step, namely the normal distribution curve, also named Gaussian curve after its "discoverer". The function changes with the parameters on which it is based: μ (i.e. the mean of all measurements, which corresponds to the intermediate value between the upper and lower bounds and summarizes the overall trend of the distribution) and σ (i.e. the standard deviation, namely the distance from the mean for each observation). As the number of measurements increases, values tend to assume a bell-shaped distribution that becomes increasingly regularl and can be described by a precise mathematical function:: $f(x)=(1/(sqr(2\pi)\sigma)eexp(-(x-\mu)^2/(2\sigma)^2)$. This predictive instrument is particularly important in relation to the possibility of employing mathematical tools to study the behaviour of a variety of real, physical, and

biological phenomena (including the throw of dice, the centimeter measurement of a population height, consumer behaviour, etc...) Although nothing can be said about each individual case, the Gaussian distribution becomes very accurate when the number of individuals in the sample is large, be these throws, patients, customers, etc...As it is often repeated: "everyone believes in the Gaussian law of error, the experimenters because they think it is a mathematical theorem, the mathematicians because they think it is an experimental fact".

[52]*The central limit theorem.* The central limit theorem is one of the most important results of probability theory. Essentially, it states that the (normalized) sum of a large number of random variables is approximately distributed as a Gaussian variable. To put it in simpler and more intuitive terms, it provides an explanation to the fact that if you add up 10 casts of dice for 10 times, most of the outcomes will be close to 30 and 40, namely the average values, rather than 10 and 60, i.e. the extreme values; and more than that: if the experiment is repeated for 100 tmes rather than 10, the result will get even closer to a Gaussian distribution, and so on, ad infinitum. Also Alan Turing, the English mthematician who is often called the father of the theory of computation, in his youth focused on the demostration of this theorem. In 1931 Turing arrived in Cambridge as an undergraduate student, and it was in the year 1933 that he attended a series of lectures on methodology of science, given by the astrophysicist Arthur Eddington. One of the topics discussed during these lectures was the tendency of certain experimental measurements to exhibit an approximately Gaussian distribution. Dissatisfied with this heuristic approach, Turing began to work on a rigorous mathematical proof of this concept. In February 1934, he was already able to attain the desired outcome of his studies but, in line with what has been an unfortunate constant in his life of virtual academic isolation, soon it became clear that the theorem had already been discovered and so that such result had been available in the mathematical community since about a dozen years earlier. With appropriate revisions, the paper was titled "On the Gaussian Error Function" and submitted to the academic evaluation. In the year 1935, at the age of 22, he was elected a Fellow of *King's College*, thanks to his original and independent work in probability, and, the following year, he was awarded the prestigious Smith's Prize.

[53] To come to life, computer science – just as many other things – needed a man and a woman. As is widely recognized, we are conceptually indebted to

Charles Babbage who designed the first programmable hardware device and to Ada Lovelace who wrote the first software. Between 1833 and 1842, Babbage, who was a mathematician and inventor, devised the analytical engine, namely a device that could be programmed by punch cards. Ada was very young when she met the scientist, who was forty-one at the time, and she showed an immediate passion for his project: in a short span, she had acquired the necessary skills to deal with the analytical engine and she was the first to realize the endless possibilities of programming. The first computer program in history was found in one of her many letters on the subject, namely a set of written instruction for the device invented by Babbage. Lovelace's software was aimed at generating the so-called "Bernoulli numbers", a sequence of rational numbers which was studied for the first time by Jakob Bernoulli in his "Ars Conjectandi", and which plays an important role in various mathematical problems. This program relies on a procedure analogous to that of Bernoulli, which Ada had studied with the mathematician Augustus de Morgan. Ada Lovelace intoduced the concept of cycle to underlie the procedure: the same formula is iterated several times, and at each iteration the value of a formula variable is increased, thereby generating, cycle after cycle, the numbers of the sequence.

[54] *Goedel's theorem.* The solution to the second of the 23 problem which David Hilbert presented to the mathematical community in 1900 was provided by a young Austrian mathematician and lover of physics, thereby posing serious problems to the view of mathematics that Hilbert himself had advocated and promoted at the beginning of the century. In an attempt to reduce mathematics to a mere formal calculus, Hilbert tried to devise a system of axioms such that it would be able to prove all the truths of arithmetic and be demonstrably consistent. In 1931, Kurt Goedel published a paper called "On formally undecidable propositions of Principia Mathematica and related systems", where he showed, first, that for any consistent formal system S, within which arithmetic can be expressed, there is a truth of arithmetic which cannot be proved in S, and , second, that such system S can prove its own consistency if and only if S is not consistent. These two results are known as Goedel's First and Second Theorem: it is usually deemed that they demonstrate the impossibility to complete the Hilbert's program as originally conceived. Without going into too much detail, we may however attempt to describe Goedel's first theorem in intuitive terms. Let us consider the self-referential proposition G that states "I am not provable". If it were so, by Goedel's particular construction, then also the meta-

mathematical proposition "G is provable"could be proved. But this would imply that our system S proves both a statement and its negation, thereby contradicting our assumptions about its consistency. Hence, G must be unprovable; but if it is unprovable, then, what it states is true; therefore G is true but unprovable. Obviously, this explanation in current language is quite far from being an acceptable proof, while, in his paper, Goedel formalize these notions step by step through a rigorous and precise method that was later named as "goedelization" by means of which every proposition is (univocally) paired with a specific number. It is therefore possible to uniformly represent both the numbers (mathematics) and the propositions about them (metamathematics) within the system, mimicking the provability realationships among propositions with relationships between pairs of numbers. Finally, it is critical to stress that the incompleteness of a system such as S does not stem from an error like it would have been the case with Euclid's system if we hadn't included the fifth axiom: even if we added our proposition G to the axioms to construct a new system Super-S, it would still be possible to formulate a self-referential proposition Super-G as to start Goedel 's trick over again! If we were to condense the theorems into a slogan, we might say: "no matter how powerful is the formal system you may construct, there will always be something that escapes you"; in less rigorous but more intuitive terms, "no matter how well you have so far managed to describe yourself without incurring in contradiction, there will always be something that you cannot tell with certainty from the inside". In practical terms, the ability to solve the internal problems at a given level by "jumping" to a higher one within the system can be refined as to become more than acceptable from a functional perspective; nevertheless, while the error probability can be lowered, it can never, at any level, become zero. Goedel 's work is almost unanimously considered as the most far-reaching result in the history of logic: it led to fundamental insights in the fields of computation, mathematics, artificial intelligence, complexity theory, cognitive psychology and much more.

[55] *The Lisp*. Originally developed in the fifties by John McCarthy, Lisp is a programming language that indirectly owes its birth to the logical-mathematical studies of previous years, in particular Alonzo Church's work on functions (his famous lambda calculus). It rapidly became one of the most widely used languages in artificial intelligence, as well as the pioneer of a whole range of ideas that later spread to all the currently "spoken" languages of *computer science*:

just to mention two significant examples, the conditional instruction "if …then" is an innovation of Lisp (Fortran didn't have it), as the introduction of a "function" fata type. This latter feature allowed Lisp to be the first language able to implement the mathematical concept of recursion, thereby assigning it the status of father of an entire class of programming languages, namely "functional" languages. According to the philosophy of functional programming, computing corresponds to assessing the value of mathematical functions: this explains why, typically, functional languages lack explicit variable assignments and memory allocations; the general mechanism of recursive functions replace'iterations, which are the basic constructs of the so-called imperative programming languages (such as C or Pascal). Obviously, the generality of the mathematical concept of function also allows the implementation of more complex features, such as the use of functions of different levels, namely functions that may have other functions as arguments or return other functions as value. As far as the assessment of the values of functions is concerned, programmers have several options depending on the specific language they decide to employ. Let us consider the two following simple functions: $w = (x+2x)$ and $z = x+y$, and the following instruction: $w(z(1,4))$. It is easy to observe that our instruction may be evaluated in two different ways depending on which function is considered first: we can either go from $w(z(1,4))$ to $w(5)$, to get 5+10 and finally the value 15; or we can move from $w(z(1,4))$ to $z(1,4) + 2z(1,4)$, therefore to (1+4)+2(1+4) and finally to 15. Several languages, including Lisp, adopt the former strategy, which is obviously one that prevents the same function from being evaluated multiple times. Others instead opt for the latter solution, which is closer to the lambda calculus, hence to the theoretical roots of the approach: on top of this, such a strategy allows to deal with infinite data structures while the evaluation of functions is always and only based on finite subsets of these lists. Albeit widely used in both the academic and the experimental domain, functional langauges are rarely employed in the industry even though they are very well-suited to avoid the *side effects* (a function that causes changes in the program state which do not correspond to the result of the function itself) and they provide greater ease of verification and optimization of the programs. One of the factors that may have critically contributed to this low diffusion is the grounded, but often exaggerated, concern about the performance of these languages in terms of speed. Nevertheless, what is certain is that complex programs written in Lisp are still used by governmental, military and aerospace agencies, as well as laboratories of artificial intelligence.

[56] On August 8, 1900, at the 2nd International Congress of Mathematics in Paris, the prominent mathematician David Hilbert, who is known, among other things, for the Hilbert spaces named after him and of crucial importance for the mathematical formulation of quantum mechanics, gave a famous speech. In the address called "Mathematische Probleme" Hilbert proposed a list of 23 problems of both logical and mathematical import which, in his opinion, were bound to be of central importance in the scientific development of the Twentieth century. The first six problems deal with foundational questions (for instance, one involves a mathematical treatment of physics); the problems ranging from the 7th to the 14th focus on arithmetic and algebraic issues (for example, the irrationality and transcendence of certain numbers); the 15th is concerned with the rigorous foundation of Schubert's enumerative calculus; those ranging from the 16th to the 23rd relate to topology and analysis. Some of these problems have not yet been fully resolved. Hilbert concluded his speech with two considerations that some regard as the 24th and 25th problems. They refer to the future development of mathematics as divided into "subdisciplines", for the field of study already seemed too vast to be addressed with a "global" approach. It is interesting to note that in 1974 the *American Mathematical Society* held a symposium both to take stock of the developments and consequences of the famous 23 problems and to make a list of the most pressing problems. This lists includes 130 problems that are divided into 27 sections: among them there stand out the problem of communication, which is related to the organization of knowledge and its dissemination, and the study of the problematic relationship between mathematical-logical research and psycho-pedagogical research.

[57] The software was designed to forecst sales in order to identify the optimal planning of production processess. It consisted of three modules that recursively called each other, with one module endowed with the "ability" to modify the other two. In particular, the module containing the forcasting formulas not only exhibited dynamic coefficients (like any econometric model) but formulas were themselves dynamic. From a technical point of view, we had exploited the characteristics of the interpreted languages that, with the proper precautions, can make changes to the software *on the fly* while it is running (for the sake of accuracy, we used the MBasic, a "famous" version of Basic developed by Bill Gates at the very beginning of his entrepreneurial career). The results were astonishing.

[58]*Systema <I>*. The relational database, which is the very heart of our business applications, builds on our extensive theoretical studies regarding the reducibility of the structure with respect to information variability. Systema <I> allows for the reduction of almost all of our programs and files to the simple definition of parameters (with obvious advantages in terms of development time and maintenance efficiency: this is our technological "secret weapon" which has enabled us to become market leader and,most of all, to maintain this lead over the years). Also the meta-structure of each application equally relies on this same logic. The ultimate question that had confronted us throughout the design phase was: to what extent can the meta-structure be defined within the structure itself? Reduction after reduction, at some point the required effort outweighed overall efficiency gains (in fact, each step forward has an increasingly high cost in terms of theoretical exertion). Finally, we also realized that we would never be able to get the full definition of the meta-structure within the structure itself. In other words, we grasped Goedel's theorem thanks to learning by doing.

[59] The phenomenon of multiple personlities is among the most controversial and still unclear psychiatric disorders. One specific element that characterizes this disorder is that an individual suffering from it experiences different identities or personalities, each of which has its own distinctive way to perceive the environment, to relate to and to interact with the others. Mild forms of this condition are present in all of us, but the peculiarity of this dosorder consists in the ability of the different personalities to take full control of behaviour leaving no trace in memory and with each state having no knowledge of the other personalities. According to our models of reference, the mechanisms responsible for this phenomenon are to be found in the operation of the module generator of conscious-Is. We can hypothesize that, throughout the life of an individual, the module is able to generate different conscious-Is that stratify over time, nevertheless, certain particular circumstances, such as traumatic events, may cause some old Is to be drawn back or some new ones to be created and then they have to coexist. Each I is a world apart which is characterized by its own ways of thinking, of handling the three minds, of addressing a situation. A number of studies have shown that some personalities may be allergic to specific substances while others are not. However, the boundary of the pathology corresponds to the presence of meta-models able to manage and provide continuity in the transition between the various Is, when this fails to occur we

witness the multiple personality disorder.

7. Psychoneurophysiology

There was a strange atmosphere in the air, some special light. Contained in that light there was a whole range of emotions all mixed up to form a perfect blend. Perhaps you might wonder how it is that a single day may be able to change the entire course of a lifetime, or perhaps you too know it well. We are not here to teach something, but, probably, only to look for some consensus.

Life is not an easy journey. Man thinks neither about his death nor about immortality, but only about dying: only the experiences endured by others (disease or oldness) determine some knowledge of the event concerning the "end".

How many times have we asked ourselves what worlds are visited by the child's mind? He lives in the realm of his imagination, his representational models are barely codified by his thought, barely sketched by his intellect, barely suggested by parents or educators. For him simulations become a playing time experienced "as if" any imagined situation were real. He is moved by the wind of time: the hours go by repeating the same sentences, singing the same characters; within himself, he is undergoing a temporal expansion, a fantastic virtual reality Neither an external event nor some noise can easily distract him from his thoughts.

After the game, the child looks more serene: his cheeks are red, as if he ware refreshened, his look is relaxed, but intense. Despite all the noise, if we browsed through his stuff, we would realize that he was having fun with only few things. His whole world was in his mind: the characters he was playing with, all their emotions, actions, struggles, peace, paths were nothing but fiction, only imagination; from a virtual point of view, his innate capabilities enabled him to aceess those creative and intuitive areas of the brain, thereby allowing him to have fun without using any toys manufactured and designed by an adult mind.

This is how we structure our mind, a seesaw between imagination, trial and error, adjustment, experience. We can train ourselves to visualize the act of dying, but not death nor immortality inasmuch as in our mind there is not yet a perceptual classification of immortality. We can envisage a disease, or suffer from it, picture ourselves dying (which is certainly related to some suffering), but we lack the logical categories that would enable us to imagine a death that is light, or even immortality that would eliminate any disease, thereby leading the individual to a destination of which he has no knowledge. We apparently fear death but we live our lives as if it did not exist, as if it was confined to be only some ultimate, final, unsolvable thing. But what if it was instead the passage to cross the river of immortality?

The developers of games often direct the child towards identifying himself in this or that character, rather than towards worlds to explore in three dimensions, where he can become the protagonist, in every sense and action, with all his imagination. The so-called simulations have always belonged to human thought, as they were created to foresee, prevent, fight, live, experience. For instance, war simulations have been employed all along, providing very accurate forecasts of military strategies and the position and movement of the enemy, and this has enabled man to experience a battle, training himself through simulation, thereby learning to know the phases of combat, before they became real. This allowed and allows to overcome the fear of confrontation: the unknown enemy is no longer so inasmuch as the situation has been dealt with before; all the effects both of a practical and a perceptual nature have been already experienced as virtual reality. The next action will be undertaken with the confidence gained from the acquired experience and therefore decisions will be made more quickly.

Nowadays, there already exist simulations of flight, launch into space, childbirth and surgery: we are standing at the doorsteps of "a priori" knowledge, of the ability to consciously express ourselves in any real action inasmuch as such action has already been experienced, at the emotional level, through the imagination. Carl Gustav Jung used the notion of collective imagination to refer to what has always existed, a sort of Platonic vision of a priori existence and of reproduction of a non-material actuality[60]. The mind is a huge receptacle for images, the engine that gives direction and stimuls to everything we perceive, experience, conceive, realize; it is a product of the brain, i.e. this great little organ that today allows survival and life and tomorrow will make immortality possible. Will we be able to simulate our existence in the infinite?

We must set our doubts, wisdom and knowledge on the mind. We must surrender to the countless abilities and possibilities that it can explore, simulate, experience. To think "forever" is an unprecedented mental expansion. We need to be able to discern the specialized skills the mind possesses and the accuracy with which it operates; a new will must erupt within ourselves accompanied by an intelligence of synthesis, a set of new, radical, inner values. The impulses to act, to respond, to react, to move, to stop, to sleep, to fecundate, to die and to survive death, all start from the brain because as, seemingly, Hippocrates already used to say "natural forces within us are the true healers of disease". So far, modern medicine has been too "transcendent" operating a neat separation between the individual and his body and disease itself. It sets disease against man relegating to the "great white witch doctor" all the responsibility for its direction; but all the patients need to be active in order to face themselves. There is no better transcendence than one's own "self", while the doctors and psychologists are nothing nut "auxiliary selves" who, with the support of the patient, fix not his "broken piece", but rather his whole being that has taken the wrong way.

So our thought begins the dance of dimensions, where space, time and places give rise to a reactive movement in some direction, namely the one that will foster the psycho-physical balance that will allow us to enjoy a wholly new quality of life throughout all the time we will have available. Our body is strictly related to hierarchized cyclical rhythms which are initially oriented to survival: the influence of experience and intelligence starts to play its role only at a later stage. The quality of life will be closely connected to consciousness: the new god will be the pursuit of "truth".

Despite social and physical conditioning, it is possible to exercise a substantial influence on our mind through training, thereby enabling it to travel out of our cocoon, projecting itself into two universes, namely, that infinitely large of outer space and that infinitelyt small of our own body, inside the single cells, among physical and psychic thoughts and pains. Our mind's time-space annulment allows us to be in every nook and cranny of our body, thereby perceiving its sound, dimension, change, evolution.

Up to two hundred years ago, our mind, being it immaterial, was conceived as something hard to define, quantify, measure. Since the second half of the Nineteenth century, thanks to the contribution of Ernst Heinrich Weber and Gustav Theodor Fechner, we have been able to measure feelings and perceptions, as well as to understand how to predict their paths and, possibly, modify their trajectory. Then it was thanks to Alfred Binet and Jean Piaget that we have started to investigate and quantify, albeit in a still approximate manner, our intelligence too: today, the use of I.Q. tests is a common practice in the most diverse situations, although often without the due "precautions"[61]. This is how it is possible to begin predicting specific individual choices, actions and reactions.

Up to only a few years ago, the world of dream was the exclusive jurisdiction of deities, a world parallel to ours which was so oddly experienced that it was impossible to describe. Sigmund Freud was the first to engage in the attempt to give sense to such abstract, yet meaningful, symbology, thereby cocluding that the dream plays an extremely liberating role in man's life, it is an extract of one's daily experience, a continuation between the actually occurred event and the non-resolution of the the event itself[62]. During sleep, dream allows to spot everything that has been elaborated by the intuitive mind throughout the day: it is where our inhibition barriers, i.e. those that under normal conditions prevent us from accessing these information, are unlocked. Thus, the world of dream becomes a virtual world, a parallel life with specific meanings, a powerful tool for the repression of mental problems.

Today, we increasingly tend to move towards a symbolic, abstract language because our vocabulary does not include everything that is elaborated, seen, imagined by the mind: it is able to simultaneously feel, perceive, experience thousands of signals in the space of a few seconds. Some of these signals are memorized, some others are deposited in specific areas of our brain (i.e. our "unconscious"); a part is processed by our left brain (responsible for logical thinking) which tries to translate those signals into something comprehensible for the logical part. Our "synthesis", our "self", works conjointly with our whole being with patience, dedication, tolerance, just as we do with our children over their growth.

The brain is such a powerful instrument that it is capable of programming, self-programming and generating. It is a tool charged with the task of teaching itself first, and then others, by means of its own genes; it is oriented towards the universe and the universal, it is able to take in any information and any sensation. The key to all this is the self-referential mechanism. Our mind can be right here and right now, but also there and then who knows where, experiencing all the visual, olfactory, sonorous sensations of that "there", taking us back and forth in time, while our body is confortably standing "here".

Such is the importance of this instrument that man has thought to take steps to create a "backup" copy, although still an imperfect one. Such is the need of immortality that today man is starting to leave something of himself into this artificial device: new intelligent softwares capable of learning and self-modifying, vocal and semantic recognition systems, etc... Just as until a few years ago, artificial limbs were employed in the field of reconstructive surgery, whereas today we see compatible organ transplants, or stem cells that regenerate themselves through the intelligence of both the body and brain.

We stand at the doorstep of an era when several sciences will come together to bring man to immortlity: in fact, thanks to computers, it is already possible to transfer the whole metaphysical world that resides within our mind (which is more and more difficult to describe in linguistic terms) at a symbolic, visual, perceptual level. Soon we will come to sensory and emotional impulses. It is possible to reproduce the mental processes specialized in imaginary visualizations and in the paths within the body, by means of sophisticated programs. Moreover, simulations are becoming reality. Complementary holistic techniques are new therapeutic languages focused on interacting with the patient's areas that appear exhausted or overloaded, sick or excited, by exploiting the benefits conveyed by the exercise of instinctively pleasant activities to the brain as a whole. If it is true that we actually learn only when we feel

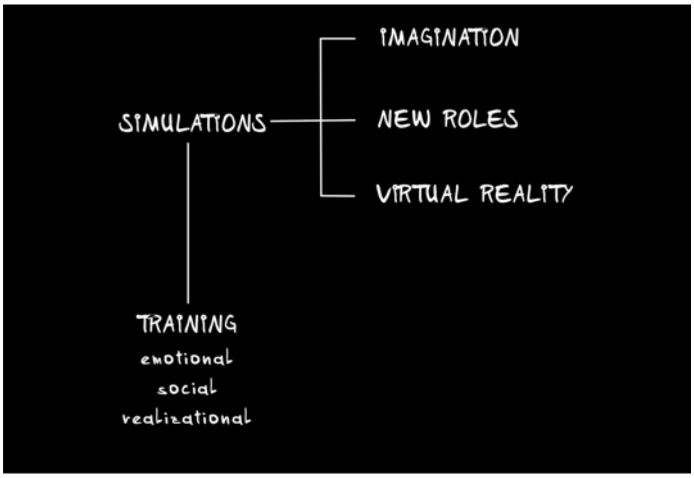

Fig. 7.1. Simulations and mental training.

pleasure, then, more than ever, the mission of education is to teach the duty of performing one's own "task" within society.

The spectacle of knowledge appears as a relative becoming that vanishes just as the dream does and it does not concern the subject experiencing it. When viewed from afar, the world of thoughts and feelings loses that dramatic nature that characterizes it when there exsists a state of identification and the subject melts into the object he experiences as an "altered" state of consciousness is attained. The meaning of sadness and fear is modified, and the *pathos* of life appears as nothing but an energetic game that we may be independent on. The desires and dogmas upon which we build our existence appear as creations of the subject, as actions or reactions to undefinable stimuli: inasmuch as they are nothing more than inventions, we can be released from their grip thereby acquiring a fully aware and detached vision of them. Good and evil reveal themselves as a relative state of mind.

7.1 From the origins to nowadays

First of all, a brief but important premise. This chapter has no intention whatsoever of being a substitute for conventional pharmacological therapies which today are irreplaceable means of cure and healing; on the other hand, it is neither an invitation to self-administration of mental techniques by means of which it is however very hard to achieve significant results without the support of an expert. We believe that in a few years our mind will be employed as the primary means of treatment of many diseases, but that time is yet to come: there are still many aspects that must be clarified before we have a safe and widespread treatment method. Nevertheless, we are also of the opinion that at present it is already possible to use the mind (i.e. endogenous instrument) to support the well-established pharmacological approaches (i.e. exogenous instruments) and that such intervention considerably increases the chances of success.

As we have seen in the chapter devoted to artificial intelligence, the origins of psychoneurophysiology can be traced back to Buddha. Probably, only today we can fully understand the meanings of some several-thousand-year-old traditions of Buddhist practice, most notably meditation[63]. Meditation is one of the primary gateways to self-reference and therefore to psychoneurophysiology. Those who practice and study it with scientific method know what it means. Those who do not practice it cannot know. Even those who practice it as some mystical or superstitious ritual just fail to appreciate its power as a whole, thereby considerably limiting its effectiveness. Meditation is to human mind as programming languages are to machines. Until we don't achieve an accurate understanding of how the models of reference are written within our brain (and thus we don't learn to directly read and modify them), meditation remains one of the few interfaces available to establish a “lower-level” interaction with our mind and, through it, with our body as well.

As shown by many researchers over the last one hundred years, from William James to Deepak Chopra, the separation between mind and body is one of the main obstacles to the development of medicine. The many physicians who obstinately persist in denying such relations bear the most responsibility for the proliferation of superstition related to the underworld of magicians and healers[64]. Neglecting the connections between mind and body not only remarkably reduces the effectiveness of the medical intervention itself, but it also drives many people away from scientific (or at least somehow "controlled") treatment contexts with all the risks that might entail. Along the path towards semi-immortality, we all must work to put an end to this separation which is a by-product of ignorance. Obviously, most doctors are actually in good faith with respect to this issue (just like many so-called "healers" conceive what they do as a mission). The reason why persons with a mind accustomed to think in scientific terms (just as a doctor is supposed to be) find it so difficult to accept the evident relations between mind and body rests on the fact that the in-depth investigation of such connections is very recent. Moreover, a certain confusion in the terms used to denote these various disciplines has further hindered their development. In the latest years, several names have come one after another: from psychoimmunology to neuroimmunomodulation, to psychoneuroimmunology, etc... depending on what among the various physiological mechanisms involved was emphasized the most. We have chosen to employ the term psychoneurophysiology because, in our opinion, it is the most neutral one to refer to the link between psyche and body by means of the nervous system.

Ivan Pavlov can be justifiably regarded as the founder of modern psychoneuroimmunology; the year 1903 saw the publication of its first work concerning conditional reflex (a concept that was later poorly translated from Russian with the expression "conditioned reflex"). Russian behaviourist school[65] has found many supporters and promoters, most notably Bertrand Russell and John Watson. In the early eighties the experimental researches of several scientists marked the resumption of the systematic studies of the relations between mind and body. Starting from different paths, many researches were just preparing to converge on the usefulness of the mental factor in the treatment of several diseases. Of paramount importance were the works of Robert Ader and of Daniel Goleman on the immune system and the effects of meditation respectively. In fact, it is only some twenty years since rigorous studies concerning this topic have been available: we hope not too much time goes by before the old-generation physicians realize it.

7.2 Definition of Psychoneurophysiology

Psychoneurophysiology is the science concerned with the study of the influences exercised by a person's mental activity on his nervous system and thus on physiology as a whole. From the point of view of diseases, it studies the possible correlations that might exist between events that are generally regarded as belonging to the domain of psychology and events that are generally regarded as belonging to the domain of medicine. Also this is a controversial topic, just like artificial intelligence, hence it is difficult to analyze it serenely. The core question might be formulated as follows: "is the human mind able to exercise a direct influence on any aspect of the body's physiology (and therefore to intervene in case of malfunctioning)?".

The steps are the following. We know that our body is totally conditioned by chemical and electrical processes. We know that a substantial part of such processes are influenced by the activities of the nervous system. And we know that some of the activities of the nervous system are managed by our mind. We know that one thought can speed up our heartbeat, make us sweat, increase the level of adrenaline. It is beyond any doubt that some physiological parameters are not immedeately available to our mind. Raising one arm is an almost completely voluntary act, modulating breath is both voluntary and involuntary, modulating heartbeat is almost completely involuntary. We are convinced that in order to attain immortality it will be necessary to achieve a thorough understanding of the dynamic underlying these processes to employ them most efficiently for the purpose of healing and prevention.

As far as psychoneurophysiology is concerned, the crucial objective to be achieved in the coming years is the identification of the active ingredient. What does allow a person suffering from a serious disease to increase her chances of recovery? Once the active principle is isolated, it will be possible to determine with certainty at what level intervention is most appropriate. Let us consider the sphere of oncological patients which is the main focus of study of our research group. We deem it possible that adequate mental techniques may lead to an increase in the chances of recovery for a substantial number of oncological patients. The improvement in the probability of recovery may occur at three possible stages. The first is to attempt to remove the causes that directly contributed to the development of the disease in order to remove those factors that might thwart the effectiveness of chemical or radiological therapies. This intervention also allows to achieve the significant result of reducing the likelihood of relapse. The second stage is to attempt to directly support the therapies by "predisposing" the patient in such a way as to increase the effectiveness of the therapy itself. The third stage is to attempt to directly intervene on the disease. Many tumor forms can be conceived as cells that escape the control of the body and that,

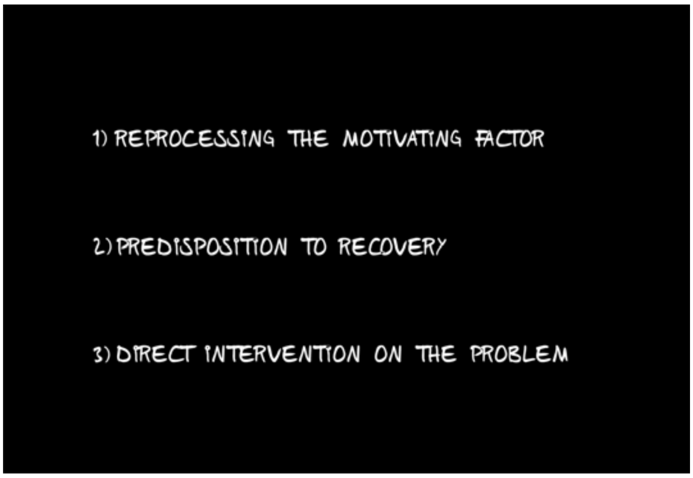

Fig. 7.2. The three fundamental stages.

for some reason, are not eliminated by the immune system. The understanding of the key factors determining such loss of control and of those regulating the destruction of bad cells may enable us to intervene on the arrest and regression of the disease by properly stimulating these factors. We expect that the accurate study of the courses of disease, both in cases of success and failure, will enable us to isolate the active ingredient in the coming years. If we succeed in exploiting the active principle up to the third stage, then the Solution to the Game will probably be within our reach.

7.3 Nervous system, immune system and endocrine system

Stressful situations affect the brain, thereby inducing adaptive responses to both events of physical nature and to certain psychic dynamics. In point of fact, it is not only the nervous

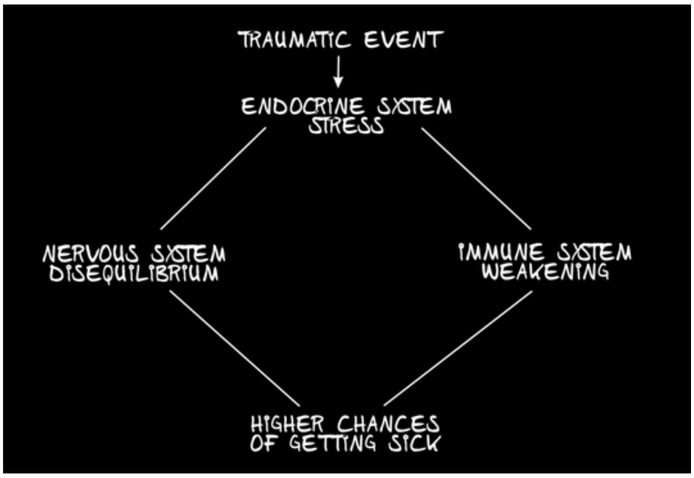

Fig. 7.3. Possible link between traumatic event and disease.

system that mobilizes itself in emergency situations, since also the immune system reacts to environmental aggressions. The involvement of the immune system in the dynamics of stress has a clear adaptive character, that is to say it is useful from the evolutionary point of view inasmuch as it contributes to the survival of an animal species in situations of danger[66]. Furthermore, the organism can be attacked both from the outside, as in the case of a wound that lets bacteria in, and from the inside by some "crazy cells", as in the case of tumor cells that, if not recognized and blocked, might spread to the rest of the body. The two systems, i.e. nervous and immune systems, act jointly in some emergency situations, therefore they can be regarded as two different levels of the same recognition and response mechanism.

The nervous system is able to recognize potentially harmful situations and to accordingly organize defense responses such as escape or attack, while the immune system is able to recognize noxious agents such as bacteria or anomalous cells and, in its turn, to organize adequate responses. Of course, this can occur only if the two systems operate harmoniously, if the attacker is not too violent and if none of the two negatively affects the other thereby reducing its function. A strong stress can lead to a nervous depression which in turn might induce a state of immunodepression which can foster the development of infectious diseases.

Many studies highlight a strong correlation between "bad" stress and cardiovascular system diseases. Bad stress is essentially related to the prolonged lack of control over the events surrounding us. Conversely, "good" stress is one that allows us to achieve the goals we set for ourselves but without exceeeding a certain level of anxiety and burden. The same token applies to depressions. In this case, there would seem to exist a significant correlation between "bad" depressions and tumor diseases. "Bad" depression is one that deeply affects a person's inner security, for instance due to a strong emotional or social disappointment. Vice versa, "good" depression leads to introspection and gives us the strength to modify our lives by promoting important choices of change. In normal situations, stress allows us to passionately face our everyday life as it stimulates creativity and initiative. Depression alerts us that we are following the wrong path, inviting us to change and improve. All this is under the control of our mind (that, despite ourselves, realizes whether things are good or bad) and that influences our body through the neuroendocrine system. When confronted with a situation of stress, our body undergoes significant modifications related to the production of hormones, the blood pressure, respiration, immune response, etc... Analogously, our mood considerably affects the same vital functions. In situations of prolonged distress, at some point our mind realizes that it does not have any control on the environment from a professional, emotional, social standpoint. If this lack of control is protracted and we fail to identify any way out we may fray our body with massive doses of stress (which is all bad at this point), or we may surrender and give up the fight thereby compromising the functioning of our immune system. In the former case, we contribute to the onset of cardiovascular diseases, whereas, in the latter case, we contribute to the onset of tumor diseases.

7.4 The state of the art and the next steps

We believe that within our mind there exists a certain number of keys able to affect, for better or for worse, the chemistry of physiological processes. Our physical efficiency (which translates in terms of both quantity and quality of life) is determined by the combination of three well-defined factors that increase or decrease the probability of a certain disease and the rate of degeneration of the different organs of our body. The first factor is the "genetic" one that, as it is well known, does not ineluctably decide our fate, but it nevertheless constitutes a significant element of predisposition. The second factor, as it is natural to expect, is the "environment", namely the hygienic conditions we live in, the food we eat, the air we breathe, etc... Finally, the third factor is our "self-referential ability" to adapt to the environment, to learn from experience, to actively seek for the best conditions for our lives, to optimize genetic advantages and to minimize the impact of genetic defects. It is the aggregate of these three factors that determines the quantity and the quality of the "time" at our disposal. Neglecting any one of the three means failing to understand the exact dynamics of any disease and of any healing process. Only if we further our researches in all the three areas we will be able to achieve semi-immortality. Today, we have a good knowledge of many of the mechanisms involved. We know with certainty that the exposure to certain chemicals increases the likelihood of developing certain diseases. Analogously, we expect that some traumatic events decrease the likelihood of an accurate response of our immune system against attacks by external agents. Just as not all the people who smoke develop lung cancer, not all the people who experience a given type of failure are struck by CML (chronic myeloid leukemia). We are convinced that even if, luckily, most people do not undergo significant physiological consequences, the chances of developing certain diseases nonetheless do increase[67].

The practice of meditation often seems to have beneficial effects on the physical health of the individual. For example, if hypertension is truly one of the factors determining an increase in the likelihood of developing cardiovascular diseases, then we can assert that meditation reduces the chances of developing that particular kind of disease[68]. But what is the active principle of meditation? No one knows for sure. Does it belong to the same domain of the placebo effect?[69] Or to that of the so-called "miraculous healings"? [70] Is it related to the biochemistry of the brain? So many questions and so few answers. However, fortunately, we have many examples to analyze and understand, free of preconceptions. Our hypothesis is that the active ingredient is to be found in the domain of self-reference. Namely, in man's ability to interact with himself. As we shall see in later chapters, we believe that the functioning of our mind stems from the interaction of a huge number of models of reference. Some of these models are responsible for governing the operations of the other models. As far as meditation is concerned, we expect it to directly act on those models that control the other models, that is, on our self-referential mechanism. The steady use of these models would lead to a considerable increase in their efficiency and, therefore, in their ability to respond.

From our standpoint, it's not so much the thoughts that have a significant impact on physiology, but it is rather the events that play the most crucial role. Thoughts enter the picture inasmuch as they determine the actions that in turn

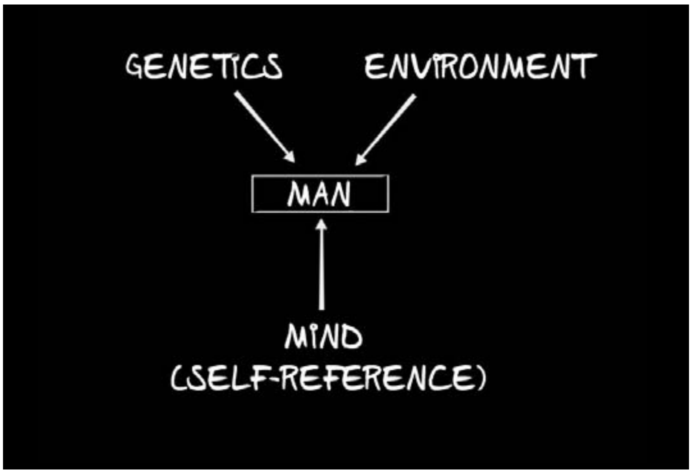

Fig. 7.4. The System Man, the 3 factors.

might foster or prevent the events from occurring. If, as we believe, this mechanism occurs both at the macro level (possible decision to smoke) and at the micro level (possible responses of the immune system), then we will have useful interpretive tools to approach the precise identification of the active principle. Specific events may trigger a certain number of models of reference that are stored in our brain, many of which are the result of the evolution of our species. Under an evolutionary perspective, the tendency to get rid of defective individuals does not come as a surprise: in the event of major failure, we can expect our body to automatically activate "self-destructive" actions[71]. Self-referential mechanisms are responsible for intervening on these processes until such trend is reversed.

Month after month, the body of medical knowledge expands and evolves, thereby bringing continuous innovation in diagnostic, pharmacological and therapeutical terms. Not all the novelties are equally valid, however the main, unambiguous consequence is the constant extension and improvement of the living conditions. Yet, as we are fully aware, the way is still long. Pain and suffering are far from being eradicated and for every sick person who recovers, another unfortunately calls it quits. In this peculiar historical period, both doctors and patients are called to a thrilling battle, namely, the accurate comprehension of how our body functions up to the lowest chemical and molecular levels. We are moving closer towards this goal by leaps and bounds: today, as never before, "to fail" is really a pity, today, as never before, "a few more months" might mark the difference between life and death. On the one hand, we are conforted by the fact that we are all facing the same conditions and that most of us, had we been born only one hundred years ago, probably would not have been here to tell; on the other hand, the sense of frustration in the face of an irresolvable disease or a distressing old age is becoming more and more painful.

[60] Collective imagination is the set of of cencepts, beliefs and symbols that are common to the members of a given community. Every culture has its own collection of information which is shared by the majority of the individuals belonging to such culture, just by the fact of growing in that context or being part of that particular group. This phenomenon is excellently exemplified by stereotypes, even though the most significant large-scale example is provided by the archetypes. According to some researchers, most notably Carl Jung, this body of knowledge would be passed on from generation to generaton ever since the primordial times, thereby accompanying man's journey throughout the centuries. If we were to express this concept in our language, however we might call them, there would be some particularly meaningful and universal models of reference forming the "common genetic heritage" of each man at birth.

[61] *The IQ*. The history of the Intelligence Quotient (IQ) started in 1905 in France, where two psychologists, namely, Alfred Binet and Theodore Simon, in response to the request of the minister of public instruction, developed a metric scale to evaluate intellectual abilities. In 1916, the Binet-Simon test was revised by Lewis Terman: it was only at this point that the concept of Intelligence Quotient (IQ) began to be adopted. Those years were marked by an increasing interest in testing, thus many psychologists engaged in the task of designing tests and related scales to measure intelligence. In the early years of the century, Charles Spearman identified two types of intelligence: i.e. fluid intelligence and crystallized intelligence. The former consists consists of the ability to effectively deal with new stimuli and situations thus it is related to the psychosocial components of personality. The latter, instead, develops from a variety of intellectual skills that mainly reflect learning accumulated through experience and education. Some scholars argue that while crystallized intelligence increases with age, fluid intelligence decreases due to the progressive loss of mental flexibility. Inspired by this theory, in 1938 John Raven published his Progressive Matrices, i.e. a non-verbal test consisting of several sequences of figures to be completed by the subject. The combination of this test and a verbal test allow to measure "Spearman's G factor", namely an index of global intelligence. Another significant contribtion came in 1939 when David Wechsler developed batteries of tests that can be applied to any age group. The Wechsler intelligence scales for adults, which are respectively named WAIS/WAIS-R/WAIS-III, are still among the most widely used tests. Nevertheless, several

authors have repeatedly expressed their doubts about the actual ability of these tests to assess intelligence, in particular in consideration of their excessive cultural biases. In fact, intelligence is not only related to the ability to solve linguistic or logical-mathematical problems: a much higher number of abilitues must constantly be taken into account, as it was cleverly argued by Daniel Goleman in his books "Emotional Intelligence" and "Social Intelligence". Howard Gardner, while not decrying the value of the test, suggested to complement this analysis with additional instruments aimed at investigating the different intelligences. Relying on a threefold conception of intelligence that is defined as a "the ability to create an effetive product or offer a service that is valued in a culture", "a set of skills that make it possible for a person to solve problems in life" and "the potential for finding or creating solutions for problems", Gardner claimed that there are distinct types of intelligence including musical intelligence, mathematical logical intelligence, existential intelligence, naturalistic intelligence, interpersonal intelligence and intrapersonal intelligence, just to name a few. , Tony Buzan, i.e. the creator of mental maps, identified at least ten different types of intelligence. In light of our approach to the human mind, we cannot but agree with these authors: a test that has the ambition of providing a sound evaluation of a subject's abilities must necessarily be able to measure all three of our minds.

[62] The year was 1899 when Sigmund Freud published a work that would change the concept of dream forever. Ever since the classical age, the dream experience has aroused curiosity and respect and it was often conceved as a communication avenue with deities (who enlightened men about future events). On the one hand, "The interpretation of dreams" debunked this belief, but on the other hand it restored the role of oneiric life as the main gateway to the unconscious. What are dreams for? Freud spent considerable time and effort pondering about this question and the answer he came up with is one of the foundational pillars underlying the complex structure of psychoanalysis. When we sleep, the delicate mechanisms, which regulate our mental life during the day, loosen their grip, therefore it becomes possible for those elements that are relegated to the unconscious to resurface. Nevertheless, such contents are often carriers of an emotional charge so intense as to produce a disturbing influence (be it agitating, exciting, irritating, etc…) on the sleeper even to the point of awakening the subject. Thus, the dream serves the function of preserving sleep by mediating the emergence of the unconscious and transforming the contents by means of

censorship mechanisms. Hence, it may be useful to retrace the path backward, thereby unveiling the real contents (i.e. latent contents) that are hidden beneath the manifest contents. To this day, no decisive and definitive explanation has been given for their actual function, even though some recent studies have highlighted possible connections between dreams and night-life brain activities such as storing the events of the day and stabilizing accumulated tensions. However, the impulse of Freud's interpreatative effort has not vanished: in fact, among the several still ongoing research projects we may single out the one which is being carried out by the branch of neuropsychology known as neuropsychoanalysis. Returning to the pioneering works of Aleksandr Lurija on patients who lose the ability to dream due to local brain damages,lsome neuroscientists are trying to identify the brain areas that are responsible for dream activity. In the over one hundred years since Freud's publication, several other studies on dreams have been conducted and we expect that the advances in the domain of neurosciences will enable us to achieve a better understanding of this particular aspect of our life. A particularly stimulating field of research is offered by the so-called "lucid dreams" that seems to be part of the experience of most people during the hours of sleep. In the late Seventies, the psychologist and researcher Stephen La Berge, relying on both his memories and those of his patients, began to realize that latent dreams constitute a research worth the utmost attention. Thefirst problem identified by La Berge was the formulation of a scientifically respectable method for inducing and recording such dreams; the second, and probably more serious, problem was to find a way to enable the lucid-dreaming patient to communicate with the observer, thereby demonstrating his awareness of being dreaming. In this respect, the most insurmountable obstacle seemed to be the negligible body activity during REM sleep. Therefore, the discovery of eye movements during this phase was of crucial importance: the dream phase is associated with specific eye movements corresponding to those made by the individual in the virtual reality of dream. La Berge relied on this discovery to overcome his problem: it is precisely by making eye movements during dream that the individual can send signals to the observer! Beyond the actual validity of the experiment, it was however important to open the way to the investigation of the nature of the mind (moving from the symbolic language of dreams to the logical and analogical languages typical of the conscious mind, attempting an interpretation of the self), in order to learn from it, analyze, discover and, possibly, solve those, previously unapproachable, unconscious problems. Interestingly, many Buddhist schools have always tried to exploit these lucid dreams so as to gain an increasingly enhanced awareness of those that are seen as harmful illusions of the mind, thereby paving the way for the maximum awareness of self and reality.

[63] There exist numerous meditative disciplines around the world, some of which are linked to religipous practices while others are not. Very often, Buddha is identified as a symbol of meditation due to his extraordinary contributions to this technique, nevertheless, it should be pointed out that, over the 2500 years since his death, there have been significant evolutions. Each of the schools that rest on his teachings has focused and elaborated on some specific aspects of meditation, while preserving its essential elements. Among the most interesting schools, we may single out the Tibetan school of meditation, which is entirely based on the teachings of Buddha coupled with contaminations from the Tibetan tradition itself and Tantrism. The Tibetan word for meditation is "Gom", which can be translated as "becoming familiar with", namely habituating oneself to that particular view of the world allowing for the identification of the dense networks of connections linking every single element of nature in a sort of universal interwined fabric. As it is the case with many other disciplines, also meditation ultimately aims at the attainment of enlightenment, but with the difference that, in accordance with the afore-explained conception of the world, this goal must be pursued not for one's own salvation, but rather for that of every single living being. These objectives may be achieved by means of two types of meditation: the former is concentrative meditation that consists in focusing one's attention on a single element (typically, the breath, a color or an image) thereby moving any thought away; the latter is analytical meditation that involves the process of investigating some concepts of primary importance to achieve the correct vision of the world. To pursue this purpose, analytical meditation also relies on certain elements of the ancient Vipassana technique (insight meditation), in order to shed light on its very nature. Meditation and the related techniques, as accurately described as they may be, nevertheless involve an individual path, whose essence can be thoroughly understood only through practice; a fortiori, this holds true for those institutions, such as Tibetan Buddhism, whose core is, in a sense, esoteric, namely composed of distinct paths that are taken at succeeding levels: it is possible to gain access to a certain level only if all the previous ones have been correctly completed.

[64] When we argue that the "traditional" medical community bears the most

responsibility for the proliferation of superstition related to the underworld of magicians and healers, what we mean is that the persistence in denying the evidence on a daily basis ends up fostering the development of these situations. Aside from what a doctor might say, people "know" that a thought, an idea and, above all, a word can be "beneficial" as well as "detrimental". Being ignored in a hospital ward or, even worse, being looked at with disdain for instance when trying to explain to the doctor the feeling that the bout of depression experienced a few months earlier may somehow be related to the disease that is taking place, all these are examples of situations that undermine our confidence in our interlocutor's ability to heal us. Inasmuch as we are "aware" of the fact that such relations do exist, it is easy to give in to superstition and resort to those spheres where anything and its opposite can occur.

[65] The culture of the first half of the Twentieth century was dominated by the behaviourist school of thought, whose underlying ideas and methods spread beyond the domain of psychology. Although it was in the United States that the principles of this theory were clearly articulated, its fundamental assumptions derived from the traditions of schools of different countries, most notably Russia. The Russian school offered its most significant contributions in the field of functional physiology, starting in the late Nineteenth century with the pioneering studies of Ivan Sečenov and Vladimir Bechterev in reflexology, the zenith of this research effort was the Nobel prize awarded to Ivan Pavlov in 1904 for his work on conditional reflexes. Throughout the Forties and Fifties, Aleksandr Lurija conducted several neuropsychological experiments that led hime to identify some of the basic connections between anatomical and psychological variables in relation to higher cortical functions. Russian functional physiology continued to evolve while constantly pursuing the search for understanding of somatopsychic relationships, thereby accumulating a large body of data. As we are often forced to point out, the road ahead, also for this field, is still long, although, fortunately, the intermediate results seem fairly promising.

[66] *Why zebras don't get ulcers.* A zebra, in the middle of the savannah, is drinking from one of the few pools not yet dried up. At one point, it realizes that a predator is stealthily approaching. At the same moment, hundreds of miles away, your boss has once again assigned you a daunting task with a short deadline. It may sound odd to you, but you and the zebra are in the same situation: to paraphrase a famous African proverb, "no matter who you are,

zebra or a human being, the important thing is to respond!"In fact, even before deciding how to deal with the problem, both living organisms have immediately begun to implement the same physiological response in the attempt to save one's own life (or job). How is it even possible that a zebra could have our very same needs? The answer is simple: we both need to provide the muscles and the brain with extra energy: we must think and act quickly; the heart has to pump blood faster to distribute glucose and other nutrients to the cells; a number of hormones have activated the sympathetic nervous system while inhibiting the parasympathetic nervous system; the adrenaline is circulating through the body. Everything is set for the vital choice, namely *fight or flight*? And it is only then that the differences between us and zebras begin to appear. In fact, animals either manage to escape or they end up being eaten. In any case, the physiological alteration is bound to terminate in a short period of time. For us, in contrast, these modifications may persist for a long time. In fact, the task may last for several days and then be followed by another and another. Human beings are confronted with countless sources of stress: the actual occurrence of a dangerous situation is not a necessary condition as just the thought or the wait for such a moment are sufficient to produce stress. Furthermore, both social and psychological factors play a prominent role in this process. Imagine a country whose army is engaged in war. The most important thing right now is that the soldiers are enabled to receive everything they need: any other activity including school, healthcare, housing can be delayed. All the resources must be directed at supporting the war effort because survival is at stake. However, should the war continue for a long time, the consequences of such a policy would be disastrous, as it is easy to imagine. We may compare our body, when subjected to stress, to a country on alert. The parasympathetic system is responsible for a number of fundamental functions such as digestion, the repair of damaged tissues, the development and maturation of sex cells and the immune system. If we neglect these activities in order to deal with the sources of stress, a variety of detrimental effects may arise including intestinal complications such as ulcers and gastritis, problems of infertility, and a substantial increase in the probability of developing cancer. Thus, what distinguishes us from zebras is not the experience of stress, but rather its management. This topic is excellently discussed by Robert Sapolsky in his entertaining and instructive book "Why zebras don't get ulcers".

[67] *Health and lifestyles*. The idea that lifestyle factors translate into significant

effects on our health is opportunely starting to achieve a widespread diffusion in our society. Constant consumption of drugs, alcohol, smoking, low physical activity, high levels of stress are just some of the causes that can weaken our body, thereby making it increasingly vulnerable to the risk of disease. In 1965, one of the first studies in health psychology, which was conducted by the UCLA, focused on monitoring 6928 residents of Alameda County (California) to measure the impact of certain behaviours on health. Today, there are countless researches in this domain: we all have experience of how everyday we are told about recommended food and drink intakes and more or less risky behaviours and lifestyles. Not only that, the latest researches are not confined to the study of various behaviours, rather they extend to the analysis of the different "styles of thought" and personality. A truly global approach, which considers the person as a whole, cannot ignore any aspect of our being. As stated by the famous slogan of a campaign for food education: "We are what we eat". It couldn't be more concordant with the facts, yet it is fair to add: "we also are what we do, think, feel, etc...".

[68] *Meditation and hypertension.* Blood alone comprises about one twelfth of the body weight, and it is vital to our survival. As blood flows through blood vessels, it exerts a pressure on the veins and arteries, cuch pressure can be easily measured with a sphygmomanometer. When blood pressure remains at medium/high levels for prlonged periods, the subject is at risk of hypertension. In this case, the walls of veins and arteries harden up to adjust to the new balanace of the body, at the expense of the average rate of flow; in other words, veins and arteries narrow dow to bear the higher pressure, thereby increasing the risk of cardiovascular diseases. In the Seventies, two psychologists from Harvard University began to investigate the effects of a "strange oriental practice" that was practiced by the students in small groups, i.e. meditation. These studies led Herbert Benson and Robert Wallace to discover that the constant practice of this technique yields positive results. Over the years, studies have multiplied and it is now a fact recognized by the leading research centers that meditation does lower stress levels, reduce nervousness and anxiety, enhance memory and wellbeing. But what does meditation have to do with hypertension? Well, there exists a considerable relationship between the two: in fact, the effects of high stress levels include the increase in heart rate and blood pressure. Therefore, stress reduction helps to prevent the possibility of developing hypertension by tackling the problem at its roots. In the United States, as well as in several

Eastern countries, meditation is recognized as one of the four fundamental measures to fight high blood pressure (along with proper nutrition, constant physical exercise and pharmacological treatment).

[69] *Placebo effect.* The term placebo, from the Latin "I shall please", refers to a substance which, while not possessing any effective active ingredient, nevertheless can positively influence the course of a disease. The effect stemming from this phenonomenon is widely exploited in medicine to study the actual results of drugs in experimental studies. One of the most-well-known cases is that of "Mr. Wright", which was witnessed by the psycho-immunologist Bruno Kopfler in 1952. This patient was suffering from an advanced stage lymphoma and he was unresponsive to any traditional therapy, but, as he read in a specialized magazine that a new "miracculous drug, i.e the Krebiozen, was being tested, he convinced himself he had to try it. Only two weeks later, the tumor mass had so significantly shrunk that Mr. Wright no longer showed any signs of the disease and thus he was discharged. Unfortunately, in the aftermath, papers reported the news of the ineffectiveness of Krebiozen. Two months after leaving the hospital, the patient came back exhibiting the same, well-known sympoms. The diagnosis was clear: the lymphoma was back. Dr. Kopfler realized that the only way to save the patient was to reactivate the same psychological mechanism (i.e. the placebo effect) that had worked so extraordinarily well. Hence, Mr. Wright was convinced to test a phrmacological medication derived from Krebiozen, but much more powerful. The new placebo drug was administered through an elaborate ritual that had been designed to reinforce th epatient's belief. Once again, the disease rapidly regressed until shortly later when the *American Cancer Association* publicly declared Krebiozen 's ineffectiveness in the treatment of cancer. For the last time, poor Mr. Wright went back to the hospital where he died two days later. The placebo effect is certainly one of the most compelling pieces of evidence for the ability of the mind-body system to self-heal and to autonomously respond to diseases, if put in the right conditions to do so.

[70] Someone defines them as miraculous healings, while others simply use the term "miracles". The fact is that every year a certain number of people suffering from serious diseases (such as cancer, leukemia, lymphoma, cardiovascularl, circular or pulmonary disorders) claim to have been healed by means of religious faith. The phenomenon takes on different forms among different religious confessions. For Christians, there are hundreds of shrines throughout

Europe and the world, the most famous of which are Fatima, Lourdes, Santiago di Compostela, Rome and Czestochowa. These sites, whose history is often related to Marian apparitions, seem to possess a special power and they attract thousands of pilgrims every year. It's been a long time since the Catholic Church has established a specific commission composed of both physicians and theologians to ascertain what cases may actually be qualified as "miraculous". The Philippines (but not only) are characterized by the widespread practice of traditional healing, where the so-called healers are persons who claim to have special "powers" that would enable them to eradicate evil through loud pseudo-operations. In Africa and Brazil, equivalent effects seem to be achieved by means of complex rituals rooted in ancient shamanic traditions. What do all these phenomena have in common? In its own peculiar way, each of them marks a moment of remarkable emotional and cognitive impact, an experience that is highly charged with expectations and upon which people often set all their hopes of survival. According to the models of the mind-body approach, all these factors would trigger an intense psychophysiological respose able to initiate a change, thereby starting the healing process. In a sense, we may call these events "large placebo effects", namely events which are charged with the hope of patients and, although no real "active ingredient" is involved, nevertheless result in a dramatic increase in the likelihood of self-healing. As we have come to know well, mind and body speak a very similar language, thus thoughts, hopes and beliefs translate into physiology. But, if it is true that all it takes to heal is the willingness to do so, why do so many peoplefail to do so? We haven't yet attained a thorough understanding of how these extraordinary resources are activated, but a few key elements, such as the importance of self-reference, are beginning to be clear. The path towards semi-immortality undoubtedly relies also on this process, i.e. our ability to cope with diseases by fully exploiting our own resources.

[71] It is a very complex topic to deal with because of its multiple implications; nevertheless, as we engage in the attempt to examine reality without prejudice and without understandable fears, we consider it highly probable that there exists a sort of direct connection between "personal failure" and "disease" for all living beings. To be more specific, it wouldn't come as a surprise to us to discover that within our mind, according to an evolutionary perspective, there exist a few models of reference which, in the event of "serious failure", would trigger "suicide" mechanisms. This process may arise as a weakening of the

immune system (and this now seems demonstrated), but it may as well occur through genuine "genetic suicides", as in the case of chronic myeloid leukemia, in which the body start to over-produce "defective" white blood cells.

8. Self-reference in the Treatment of Diseases

Had we chosen to favour only the logical mind in our life as researchers, this chapter would have never been written. Firstly, it is likely that there would have been nothing to write; secondly, even if we had actually had something to say, we would have struggled to convince ourselves of its "scientific dignity". The crucial point is that if we had exclusively employed the logical resoning module, many persons would still be suffering and some of them would have, almost certainly, died.

Until a few years ago, nearly the totality of doctors and researchers regarded the fact that the mind can considerably influence the body merely as a "non-logical" concept. During the development of our representation model of mental processes, we came to realize that the human mind is not only logical, but it is indeed also analogical and realizational. The study of the analogical mind enabled us to become aware of its ability to reach thoughts-decisions that are often extremely useful for survival. Obviously, achieving an exact understanding of the causes of an event guarantees an interpretive soundness that is superior to that of any other module; the problem is that we are still far from understanding everything. From a scientific viewpoint, the main defect of the analogical mind lies, by its own nature, in its failing to be perfectly punctilious; the lack of rigor coupled with emotionality might be a fertile ground for superstition. Nevertheless, it is precisely this part of our mind that allows us to be creative and to explore new paths: a well-developed analogical mind disciplined by an equally well-developed logical mind is probably at the very foundation of any scientific discovery. Finally, there is the drive to implement one's own insights and such push can only be given by the realizational mind. The attainment of something really useful necessarily entails dirtying one's hands: all the rest is just words.

Along the path towards semi-immortality, we have always deemed it vital to be granted access to the realm of our own healing abilities: to put it in simple terms, some people have the gift of "knowing" what the others have to do to feel better. This is probably a little scientific statement, but we wouldn't know how else to effectively convey such concept. There are persons who "know" how to play an instrument or paint, persons who see regularities where others see nothing but chaos and there are persons who "know" how to heal. As it is well-understood, we all can learn to play an instrument, but only a very few lucky ones can really do that. The identification of the active ingredient (or the active ingredients) of the musical genius might be an interesting object of study, nonethless, at least from the standpoint of semi-immortality, it is certainly subordinate to the need to isolate the active principle of the medical genius. How and what does a good doctor see that an ordinary doctor does not see? Why, at the end of the day, is a good doctor nearly always right, although his mental path is often not linear? The lack of falsifiability of these questions considerably hindered our path in its early stages, in part because we were disturbed by the underworld of emotional superstition that is bound to proliferate in any non-scientific contexts, in part due to the fear of being distracted by unattainable, or however unreproducible, goals. Then we convinced ouselves to continue our investigation, as they say "don't throw the baby out with the bath water". Therefore, we started to test and to directly observe the results of our experiences, obviously taking into account what other researchers claimed to have achieved, always giving them the benefit of the doubt. In a sense, we confined ourselves, however with all due verifications, to the description of what we actually observed without dwelling too much on the various possible interpretations of data.

Over the past five years, our psychoneurophysiology department has systematically followed about a hundred people. Approximately half suffering from problems of a physical nature (mostly tumors) and the other half suffering from problems of a psychic nature (phobias, depressions, addictions, eating disorders, sexual disorders, etc...). As it is often the case in such circumstances, most people come to us after unsuccessfully trying "conventional paths", namely, those encoded in standard treatment protocols. The route, understandably and perhaps inevitably, goes as follows: I feel sick and I undergo some examinations, I discover I have a disease, I turn to "regular" medical facilities, I begin to get treated. After a few months, if I don't register significant improvements, I start to lose confidence in the methodologies I am following and, at this point, I might have two reactions: either I resign to the disease and thus, in case of serious illness, to death, or I look for alternative itineraries and I undertake a path where it is difficult to distinguish science from superstition. Especially in the earliest years, people turned to us after a long peregrination, and, therefore, in an advanced stage in the case of physical disease, and in a chronicized situation in the case of mental disorder.

Consistently with our primary goal, i.e. semi-immortality, our researches in the domain of psychoneurophysiology have been predominantly focused on the comprehension of the mechanisms of self-healing. To put it in more precise terms, we have constantly been concerned with investigating what factors, within an individual, may contribute to increase the likelihood of recovery and, symmetrically, what factors instead contribute to reduce such chances. Along the way, we came to the conviction that both our body and our mind play a crucial role in this process. Adequate physical activity can critically contribute to the resolution of psychic disorders and adequate mental activity can critically contribute to the resolution of physical diseases. From here stems our approach based on first, considering man as "system man", second, on providing truth with functional value and, third, on regarding a person's mind not only and not much as a single mind, but also as a mind composed of "modules". From here also stems our intuition of the existence of the "models of reference" as the basis underlying our thoughts, our perceptions and our behaviours.

Hence, our approach builds on the ability of the system man to be self-referential, namely the ability to self-modify. We believe that the enhancement of such capability in all of its stages (realize, evaluate and act) may provide an essential contribution to the resolution of any disorder, be it of a physical or a psychic nature. The proper activation of the models of reference within our mind, or the creation of new ones by a therapist (be him/her a doctor, a psychologist or, why not, a friend, partner, etc...) are the key instruments of treatment. According to our approach, even a medicine creates a new model of reference for our body, namely, a typically exogenous model of reference; in a perspective of semi-immortality, the first best would be to have a functionally equivalent model be endogenously developed by our mind-body system, but this is not always feasible. Until we attain a thorough understanding of all the mechanisms involved, any external support in the form of drugs or surgery must be welcome.

8.1 Meditation

Our studies clearly indicate meditation as one of the fundamental tools to develop a person's self-referential skills. According to a traditional definition, "the purpose of meditation is to unite the thinking mind with its source of pure awareness". In modern terms, "pure awareness" means inner space: the silent empty void that is the womb of all matter and energy. Pure awareness is in the gap between one thought and another, it is the somewhat unchangeable background, against which every mental activity occurs. Since our mind is constantly occupied by thoughts, desires, dreams, fantasies and sensations, we normally do not realize the potential of meditative state[72].

It is the case for many people that the use of terms such as "pure awareness" or phrases such as "the silent empty void that is the womb of all matter and energy" immediately (and justifiably) incite automatic mechanisms of suspicion. In the continuation of the chapter we will employ symbol terms related to meditative practices such as "lake, throat, or pituitary gland meditation, etc..." or again "yellow energy center, unclenching plexus, consciousness shifting technique, etc...". As a first approximation, for further information, refer to the notes of the chapter and to the brief bibliography at the bottom of the first note. As for any "suspicion" regarding the use of these terms, a concise premise might be useful. It is easy to verify that meditative practice takes our mind into a "symbolic universe" and an interesting property of such symbolic universe is its ability to exercise a direct influence, for better or for worse, on our body's physiology. According to our researches, this probably occurs thanks to the activation of certain models of reference that are inscribed within our mind. These models, in turn, seem to possess the striking property of being shared among a large number of people even belonging to very different cultures. In this perspective, the use of "evocative" symbolic terms constitutes one of the basic tools of meditative practice (of course, as long as we share their underlying meaning).

As we know, the endocrine glands and the nervous system coordinate their action on all body cells to make them work at a pace appropriate to the particular situation in which the individual finds himself. At rest, the blood must contain a constant amount of sugars, minerals, oxygen, etc... In some cases, for example when engaging in physical activity, muscles need additional nutrients (especially glucose) and oxygen; hence, the liver releases glucose from its stores and heart rate and breathing movements increase: at this point, blood is far richer in sugar and oxygen than in normal conditions. If the muscles do not burn it all, then the system "thermostat" intervenes so that the surplus is eliminated and blood returns to its constant levels. The same thing occurs at the mental level: a balance is established between all the stimulations surrounding us and our personal thoughts. Hence, our daily life is composed of a chain of stimuli which, for a moment, alter our biological rhythms and the clarity of our thoughts, which impose a sudden acceleration only to slow down at the subsequent moment until everything resumes its normal speed. The stressful attack is much more intense than momentary stimuli and, rather than to a single accident, it may be compared to a series of collisions so rapid that there is no time to recover from one shock before the next one occurs. This causes a much deeper, and often longer-lasting, perturbation than the small, continuously varying shocks of everyday life. All the regular biological oscillations are violently exaggerated, thereby exceeding the usual limits.

Learning to use meditation leads to the restoration in the balance of the system man, as the cellular oxidation of the nervous system is reduced and biological cells are regenerated: finally the order in the organism is restablished. For instance, noradrenaline is a neurohormone which is involved in several functions. Besides performing its main task, thereby sporadically affecting emotionalism and stress, its regular surges are essential to provide us with the vitality we need in any endeavour of ours and to let us find satisfaction in what we do; finally, it plays a crucial role in helping us to regain a good mood in those unlucky days when we go through hard times. When, for any reason, the production of this substance by the cells decreases, we feel we have had enough of everything, we keep on repeating ourselves that there is no remedy to our situation and that things will never possibly be good. The tonics sometimes prescribed by physicians fail to deliver remarkable results: noradrenaline cannot be administered in the form of medicine. The only way to get rid of stress is to induce the body to produce more of it: this is what meditation is for.

The psyche-body connection related to noradrenaline can be represented by an arrow from the bottom of biochemistry to the top of positive feelings and attitudes. Of course, the influences between the parts of the system man can also move in the opposite direction, i.e. from feelings to biochemistry. A significant example is supplied by norepinephrine: it was found that negative emotions promote the release of this chemical messenger, which is known as a suppressor of immune function. Another example of *top-down* influence comes from a study on cancer patients: it seems that the visual imagination technique (namely, the "symbolic" use of mind) fosters an increase in the activity of the killer cells and a reduction in tumor growth. All this further corroborates the role of our moods and of the "positive" exploitation of our mind in maintaining health, as well as the importance of having a systemic view of the organism.

When people talk about their "personal demon", their words are not to be understood only in a figurative sense. The demon residing within us may put into our minds ideas that might make us suffer just like a physical assault; it encourages us to face situations marked by frustration or conflict which might lead to unbearable tensions. Very often and without our knowledge , it is suggestion that imposes these thoughts that are nailed into our head. Although we might be not wholly aware, most of us are suggestible to some degree; media, advertising, all means of propaganda makes us live in a bath of fantasies of all kinds. Often unknowingly, we absorb a remarkable amount of beliefs about the art of living, the meaning of everything: work, vacation, love, health, etc... A significant number of experiments were designed to measure this tendency to be influenced. In line with the systemic approach, the most recent discoveries in the domain of psychoneurophysiology show a deep interrelation between thoughts and emotions. Emotions and sensations would not only underlie the memorization of experiences, but they would also be responsible for most of the physiological mechanisms that either regulate or block the functioning of the whole living organism.

Every emotion predisposes us to action in a peculiar way; each of them guides us in a direction that has already proved successful to overcome the challenges recurring in human life: external situations that repeat endless times throughout our evolutionary history. The value of our store of emotions for survival is confirmed by its being imprinted in the nervous system as innate behavioural baggage. In other words, the proof is in the fact that emotions end up becoming automatic tendencies of our way of thinking.

Today science provides us with tools to assess the role of emotions in our life. As we all know from our own personal experience, when it's time for decisions and actions to take shape, feelings count at least as much as rational thought, and often even more. So far, in human life, too much emphasis has been placed on the value of the purely rational sphere, namely that measured by IQ. For better or for worse, when emotions take over, the "logical" intelligence cannot be of any help, since reason is often blurred: this feature of human nature derives from the neural architecture underlying mental life. The same root of the term "emotion" is the latin verb *movere*, "move", with the prefix "e" (movement from), to indicate that a tendency to act is implied in every emotion. Each emotion plays a unique role which is marked by its distinctive biological features. Thanks to the now available methods enabling us to peer into the body and brain, researchers are discovering further physiological details on how each single emotion predisposes the body to a very differentt type of response. The circuits of brain centers which are responsible for regulating emotional life unleash a flood of hormones that put the body in a general state of alert, thereby preparing it to action and focusing the attention on the looming threat to evaluate what is the best response. As far as happiness is concerned, one of the main biological changes consists in the increased activity of a brain center that inhibits negative feelings and fosters the amount of energy available along with hindering those centers that generate distressing thoughts. Love, feelings of tenderness and sexual satisfaction involve the stimulation of the parasympathetic system, a "relaxation response" that puts the whole body in a general state of calm and gratification as to facilitate cooperation. Sadness performs the fundamental function of making us adapt to a significant loss, for example, a major disappointment or the death of somebody. It entails a fall in energy and enthusiasm for the various activities of life, in particular leisure and pleasures, and, when it becomes deeper, thereby approaching depression, it has the effect of slowing down metabolism. The closure on ourselves which accompany sadness provides us with the opportunity to process the grief, to understand the consequences of certain events on our own life and to get ready for new projects when the energy comes back. These biological inclinatioms are further shaped by personal experience and culture.

Becoming aware of all these mechanisms and learning to manage them properly is an essential step in the path towards semi-immortality; at present, meditation is one of the few acknowledged tools able to bring us closer to this kind of awareness, not only from a theoretical point of view, but also in the realm of practice and implementation. It is precisely for this reason that meditation is one of the principal supporting techniques employed in our psychoneurophysiology laboratory to assist people who request our help. We specifically speak of "supporting technique" because we do not believe that meditation is the actual active principle, but rather re regard it as an excellent context in which the active principle itself can, for some reason not yet fully clarified, act[73].

8.2 Introduction to case history

Now, we will describe the typical path that people follow in our laboratoty through the exposition of five cases, chosen among the hundred or so cases at our disposal. It is convenient to begin by clearing the field by any ambiguities in order not to raise false hopes: obviously, what we have said in the previous paragraphs implies that the path we are presenting is not a protocol, in the standard, scientific sense of the term; on the other hand, we absolutely do not know what the active principle at work in such path is, nor we are able to define how it relates to the methodes employed. Finally, the generalizations we draw from the cases, by themselves, have little chance of providing our logical mind with a satisfactory explanation. In other words, this part is perfectly in line with the philosophy underlying this chapter: even though we haven't understood the "whole", we are already able to do something. In consideration of the importance of this something, we have nonetheless decided to communicate our experiences, forgiving ourselves for the many questions to which we still need to provide adequate answers.

In an ideal world, most people would find themselves in a condition of balance. Such state is far from easy to define: as a first approximation, we may say that a person is in balance when his psyche and his body cooperate for the well-being of the organism as a whole. Unfortunately, it is not an ideal world we live in: day after day, the small accidents of everyday life eventually cause more or less serious imbalances in all of us; under equal conditions of negative stimuli, a better genetic endowment guarantees a greater ability to resist. The transition from imbalance to disease is not logically contiguous: in most cases, health significantly deteriorates only after a particularly traumatic event. A shocking episode, an unprocessed grief, an overwhelming disappointment, a consuming frustration: the way we live every episode of our existence underlies the onset of our diseases, both mental and physical. In the early stages of the common path, often the person, in dire conditions, doesn't even know whether he truly wants to continue fighting for his life or, rather, to drift off to death which however appears very likes in a a lot of cases. Psychoneurophysiology does not promise miracles, and the path to be taken to restore balance is long and burdensome: each step requires great disciplime. In order to recover, patients are helped to gain (or regain) indipendence, strength of will and optimism: often, periods of well-being are followed by moments of regression to which it is essential to know how to react.

The five selected cases belong to different types of disease: on the one hand, we have two “mental” disorders (namely, fear of death and panic attacks in case 1, various addictions in case 5), on the other hand, we deal with two “physical” illnesses (chronic myeloid leukemia in the cases 2 and 3 and cancer in case 4). At first glance, the fact that all the patients have received an essentially analogous treatment, namely employing the same basic techniques (perhaps according to different modalities) may strike as anomalous. Nevertheless, if mind and body are one and the only practicable approach is a systemic one, then the suppleness characterizing psychoneurophysiology should come as no surprise. We can assert that the techniques used in psychoneurophysiology operate on (at least) three distinct levels. First, there is the work on the causes of the disease: we must precisely identify them and ensure they can no longer be a threat or an obstacle to the healing process; the second level is comprosed of all those steps of the therapy which act to "predispose", in the broadest sense, the patient to treatment, thereby improving both the effectiveness of traditional medicines and the quality of his life (i.e. treatment against pain, control of side effects, etc...); the third level is the intervention on the disease, that is, the real cure. The work on the symbols of the mind plays a crucial role at every level. In fact, the first contact with the unprocessed trauma can often be established only through a connection with the "unconscious". Furthermore, the mastery ofmeditative techniques allows the patient to be better equipped to face the full range of standard medical treatments that psychoneurophysiology accompanies. Finally, although it is not considered as the real active ingredient, meditation appears to be the main technique able to create the adequate conditions to activate the active principle itself. Other techniques are more specific. The direct interview with the patient mainly belongs to the first level: once meditation has identified the area where the event must be looked for, it is for dialogue to fully understand what happened. Instead, a particular diet and regular exercise (generic, such as the long walks of case 3, or specific, such as the exercises of case 1) mainly fall in the second lvel: by contributing to the overall health of the body, diet and gymnastics put the patient in the best conditions to respond the treatment.

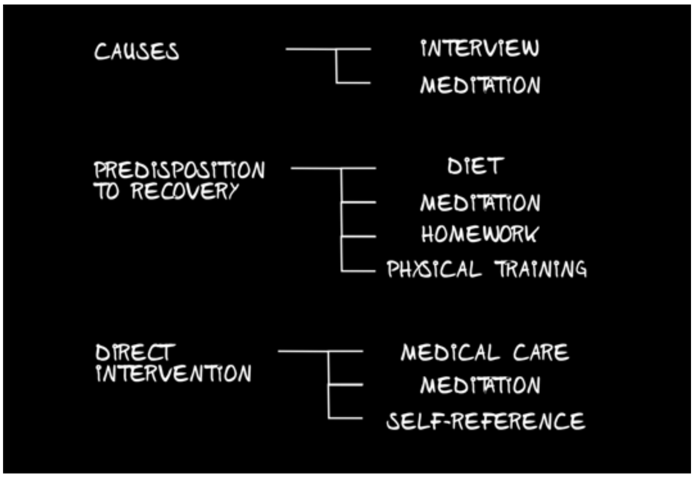

Fig. 8.1. From the analysis of causes to direct intervention.

Techniques against pain help both psychologically and physically: as he realizes that pain diminishes, the patient takes the treatment path in the laboratory with a good attitude. Later these same techniques can be employed to reduce the constant, exhausting physical pain caused by clinical tests, medications and surgery (see, for instance, the results of case 3). Finally, the various types of "homework" (such as the diary in the cases 2 and 3) which are assigned to many patients support the other phases of the treatment as, on the one hand, they provide the therapist with valuable information about the performance of the treatment itself and, on the other, they give the patient a continuous stimulus to improve. At the end of the treatment, each of the five cases we are about to present obtained considerable results in all the areas covered. From a physical standpoint, the situation has improved for all of them: physical diseases regressed or remained stable, while the physical ailments that affected psychologically problematic patients stopped. From a mental point of view, the progress is clear: in

Fig. 8.2. From the event to recovery.

the cases 1 and 5 psyche fully stabilized; in all the others, each patient lives with a new self-consciousness and thus he is able to cope more peacefully with all the aspects of life. Therefore, it is no wonder that also their relational life has returned to a full and unexpected stability, both in the most closely affective spheres (partners, family ties, etc...) and in the social and professional contexts as well. In a nutshell, they all have finally concluded the path towards the restoration of a flexible balance. And more than this: each patient now can find within himself everything it takes to preserve his well-being by tackling the possible causes of imbalance in everyday life.

In conclusion, two remarks concerning the form of exposition of the five cases. Consistently with the philosophy underlying this chapter, we have chosen to present each treatment path in a twofold light: in fact, after a brief introduction, each story is exposed in two different registers, first with an analytical approach, presenting the therapies, results and techniques adopted and then in an anlogical mode, outlining a sort of inner biography of the patient. The latter is precisely related to the description of the different phases of meditation: even at the cost of making the first case considerably longer than the others, we decided not to relegate the explanation of the techniques to a footnote, addressing it step by step as new elements are introduced.

8.3 Case 1: the R.T. case

Mrs. R.T., aged 47 , arrives to our laboratory in a situation of serious psychic disorder: she is terrified of dying, she cannot keep her eyes close (she sleeps only with sleeping pills), she has frequent panic attacks in public places (sweating, confusion, sight problems). The triggering event was her awakening during surgery, but the situation has further deteriorated due to a friend's death from cancer. Our intervention is the latest in a long series of attempts: before us, neurology, psychiatry and acupuncture haven't delivered any positive result.

The clinical path

After determining that the person does not suffer from any disorder of pathological nature, the therapy is initiated: in order to regain balance, it is necessary to be able to face and overcome the fear of one's own death and that of other people. The case is difficult, this is preciselt what gives R.T. a strong determination to get out of this state of anxiety. The first phase of the path, running from the first month to the fourth one, is marked by a solid relation between the patient and the therapist: in-person meetings are three per week and the availability ("physical" and on the phone) of the therapist, in the first two months, is absolutely complete. The earliest weeks together are devoted to teach the patient a few techniques enabling her to take immediate action against the symptoms of her malaise:

R.T. quickly learns to control her breathing with will (to restrain panic) and to execute specific physical exercises against muscle stiffness and pains. In parallel, the more strictly psychological work begins, by means of music and symbolic visualizations: in only two weeks, the patient is already able to close her eyes without panicking and, day after day, to experiment with simple forms of meditation. Moreover, at the end of the first month, it is already possible to complement the meditative part with a series of selected readings. The results, at least as far as symptoms are concerned, are already evident after four weeks: the patient is now able to react to panic, by controlling her breathing, maintaining body balance and preventing muscle stiffness.

From the second month on, sessions begin to assume a well-defined structure: 30 minutes of meditation, 20 minutes of exercise, followed by 10 minutes of interview. It is only at this point, namely, when the symptoms have been partially addressed, that the actual phase of "removal" of the problem can start by means of the beginning of meditation within the body ("lake meditation") and of the work on the patient's past which is conducted through the interview. As the therapy progressively consolidates, there continue the small conquests over the symptoms of the disorder: in the second month, we have the first daily suspension of tranquilizers; by the end of the fourth month, the patient manages to close her eyes and surrender to sleep, even if for a few hours only. The relation with the therapist begins to undergo a slight change: after the initial climb where the patient needed to be taken by the hand (literally), now it's time for greater autonomy; although the phone availability remains total during the day, R.T. has the task of facing the night alone.

The second phase of the path (i.e. the fifth month and the sixth one) sees a reduction in the frequency of the interviews from three to two meetings a week. Concurrently, the contacts between the therapist and the patient become rarer: outside the sessions, the patient is allowed to get in touch with the therapist only in case of an emergency. In this phase, it is of cardinal importance to further stimulate the progresses achieved inmeditative techniques: R.T. is introduced into a new level ("heart meditation") and, with the guide of the therapist, she experiences a virtual shift of consciousness. This step is of twofold relevance for the health of the patient: on the one hand, inasmuch as she has to undergo surgery without anaesthesia, such technique enables her not to feel any pain; on the other hand, since it makes her aware of her ability to succesfully deal with a surgical procedure, it plays a key role in overcoming the fear of surgery and the dread of death from which all her problems actually stem. To this day, R.T. faces any medical intervention in full autonomy.

In the third phase (i.e. from the seventh to the eleventh month) the patient is heading for the conclusion of the therapy. The sessions are weekly, and the overall wellbeing of the patient is steadily increasing: for the first time in years, R.T. is able to deal, alone and successfully, with the crowded underground and supermarket shopping . What's more, she now masters allmeditative techniques, including "throat meditation" (seventh month) and "pituitary gland meditation" (eleventh month). Furthermore, the patient manifests a full awareness of the path she has attained, of the importance of meditation in her life and of her renewed attitude toward death. With the support of her accomplishments and her remarkable cooperation, it becomes easy for the therapist to implement countertransference. The final phase of the path of R.T. is characterized by the return to a fully satisfactory life and to a complete balance: the patient is autonomous in all her activities, she no longer takes sleeping pills, she confronts herself with public places on a daily basis and she hasn't had a panic attack nor any muscle problems in months. Two episodes, potential causes of serious imbalances, significantly show the stability she has achieved. At the twelfth month, R.T. is reached by the news of the deadly disease of a friend of hers. The patient faces such situation with courage and composure, availing herself of additional interviews with the therapist and she assists her friend throughout the final period of her life. Sixteen months after the beginning of the shared path, upon the advice of the therapist, the patient also decides to get rid of smoke addiction: no chemical surrogate is allowed, but she rather has to rely only on the constant support of therapy and the continuous practice of meditation. Four burdensome weeks later, the patient no longer feels any need to smoke. After a few months, the sight of other smokers no longer has any appeal to her.

The inner path

From the day I suddenly woke up during that surgical procedure, I have found impossible to live on. The only part of my Self with which I continuously have to come to terms was fear, in its broadest sense: fear of death, mine and that of the people I love, fear of going into crowded places, fear of falling asleep, fear of having fear. I had practically ceased to live; any everyday action or thought, even the most trivial one, looked like an invincible and terrifying monster. The mere act of closing my eyes would plunge me in such a state of distress that prevented me from sleeping at night. Even going to the shops was a source of major anxiety: I felt like, at any moment, I would be trapped inside a large iron box; my heart seemed to explode inside my chest, my sight blurred, my legs suddenly stiffened. Moreover, a dearest friend of mine had just died of cancer: if anything, this brought one further fear to the mishmash I found myself immersed in. Nevertheless, two things never failed me, namely the determination and the will to return to live my life.

At the beginning of the therapy, I couldn't close my eyes and let myself go; the doctor decided to guide me into peaceful mental visualizations, during which I felt like a child who was just starting to relate to the world surrounding her. I learned to regulate my breathing, to take control over my body and pain, and I began to realize that in the end I wasn't but a being immersed in the world. The breath was mine, and mine were those annoying and painful attacks that kept me from serenely living my life. As soon as I managed to attain a certain level of relaxation, we began to meditate with the eyes closed. The first place I was taken to was an ample, green, bright woods: I was able to distinguish every detail, I could hear the sound of the wind into the trees, I perceived the odors emanated from the shrubs, I listened to children's voices in the distance. It was in this place of mental serenity that we decided it was time for me to overcome the first of my fears: while she was holding my hand to accompany me in the intricate journey within mysef inside this woods, totally immersed into nature, the doctor made me visualize the vivid image of my departed friend. It was then that I began to cry and I felt all the tension from the past flow out of my body. Tears were accompanied by a big smile: I had just defeated my first demon.

Then, we engaged in a new form of meditation, i.e. lake meditation: I was inside my body, approximately at the height of the navel, where a yellow energy center was spreading all its dynamism. I opened the plexus and a large expanse of water appeared before me. I had to calm the waves that, every now and then, were rippling the surface, thereby leaving the bottom of the lake, where my consciousness was, clear before returning to the surface. Once I had emerged, the lake became a large mirror where my consciousness reflected. After meditation, I could feel a renewed liveliness within myself, the emotions I preserved were more limpid, as if they had attained a new awareness and harmony. I achieved a state of emotional quietness that I had never experienced before. This is how, before I knew it, I managed to unexpectedly change my relation between the internal world and the external one: I was starting to perceive death as an unavoidable consequence of life, as a sort of balancer of life itself. I was on the right track to abandon my fears and the attainment of this first goal enabled me to feel much more self-assured of my capabilities: my self-esteem had considerably risen. In order for my potential to come to full bloom, we moved to the next meditation: heart meditation. A plexus of green energy, which is located at the height of the heart, turns into a white flower composed of twelve petals. As they, very slowly, open, the center of blue light, located right in the middle, unleash all its force. By then, I had achieved a certain inner strength, but the mere idea of undergoing another operation – a simple root canal treatment that was scheduled for a short time later – led me to be caught by the fear of regressing to the initial stage.

Therefore, the doctor came to the dentist with me, and together we suceeded in overcoming also this trauma: I remember her taking my hand and guiding me into a particular meditative state, where my vigilant consciousness was observing my fully relaxed body, as it was floating above my body and not within it. Little by little, while the dentist was doing the root canal, my consciousness flew, first, over the room I was in, then, over the city and finally, I found myself hovering in the blue of the universe. At a certain point, I reached an island of golden sand, which was naturally lit and heated by the sun, surrounded by a transparent blue sea. I refreshed myself in these invigorating waters and I let my mind be drifted by the calm and steady rythm of the waves. When my consciouseness went back into my body, the dentist had already finished his work, I hadn't felt any pain and so I realized I had defeated the trauma of anesthesia and the fear of death. However, we accomplished our meditative path by completing the last two visualizations left, i.e. the throat meditation and the pituitary gland meditation. We focused the attention on the plexus of light-blue energy, located in the middle of the throat: this time, my consciousness would be assigned the task of wiping out the whote clouds (i.e.mental nebula) from the blue sky that would appear with the opening of the plexus.

Later on, I decided to face the second medical intervention by myself: by that time I had overcome the sense of guilt over the abortion I had undergone (and which I managed to see and address as a problem only later) and I could conceive life as a flow and death as its natural consequence. I was no longer scared by the idea of dying: I conceived the process as a transition from my body to a state of universal harmony. At this point, I had achieved such an awareness of myself and my past fears that I began to live again; the queue at the supermarket wasn't a problem any more and getting on the subway now caused me no anxiety. The practice of detaching from my emotions allowed me to finally remove that sense of oppression I used to feel when trying to fall asleep or staying among people. I brought my inner meditative path to a close by visualizing the last plexus, located in the middle of the forehead: a two-petal flower becomes the core of my consciousness and I learn to live in the dimension of inner silence. I realized I had got the better of my inability to face death and disease when I managed to accompany a dear friend of mine to death, without being adversely affected by that. I was left with just one last "transitional object" from which I couldn't tear myself away, namely, smoking (at that time I smoked almost two packs of cigarettes a day). The doctor helped me understand that I was, in a sense, a debtor to nature and the energy that had supported me throughout my healing path: with the will and courage, which had never failed me, not even in my lowest moments, and with the support of the therapist, I managed to get rid for good of my last "mental intoxication". I was finally free.

8.4 Case 2: the I.T. case

The patient I.T., aged 41, began treatment in our laboratory thirteen months after finding that she was suffering from chronic myeloid leukemia. One year before the diagnosis, she had separated from her husband; moreover, the psychologist who was treating decided to interrupt the therapy when the news of the disease came. Therefore, I.T. comes to us with two griefs to process on a psychological level, as well as physically debilitated by the illness: treated with the antineoplastic drug Imatinib, the patient suffers from anxiety, fever, hyperactivity, hyperkynesia, muscle aches, swellings and insomnia.

Il percorso clinico.

In the first phase of treatment (from the first month to the third month) it is essential to reinstate a minimum level of wellbeing into the patient's daily life. In order to attain this goal, psychotherapy (interview, diary of emotions, guided readings) and the practice of meditation (plexus visualization) must from the very beginning, be coupled with an intensive program of physical activities: postural bench, yoga, stretching, relaxation training in the water and massages. Furthermore, the therapist also recommends a diet based on antioxidant elements and the frequent consumption of herbal teas to promote the relaxation of the nervous system. From the earliest sessions, the patient already manifests significant improvements: the techniques learned enable her to reduce the dose of sleeping pills (to only three doses a week); she feels more lively and, after a long time, she returns to going out by herself. The results of the hematologic tests are good: the disease appears to be in partial remission. Nevertheless, serious psychological problems do persist: the patient is unable to fully accept herself. As a side effect of the medicines she has been taking, she gained fifteen kilos and she is swollen; her attempts to take diuretics to reduce excess fluids cause imbalances in other areas of the organism. This is why, in the second and third month of the treatment, the interviews are mainly focused on the issue of self-acceptance. In parallel, we decide to work on the physical level to support the body over the reduction in the daily dose of cortisone (from 20 to 10 mg per day): the program set by the therapist involves gymnastics to improve physical stamina and massages to mitigate muscle pains.

At the beginning of the second phase of treatment (running from the fourth to the sixth month) the patient is in full recovery: after six years of continuous use, she no longer takes sleeping pills, muscle aches have eased and she has improved her core physical qualities (i.e. strength, balance, coordination). Unfortunately, during the bone marrow aspiration, I.T. does not manage to effectively implement the pain reliever techniques she experimented with during the sessions. The shock is such that the path of the patient undergoes a setback, if not a regression: she resumes taking sleeping pills and she reports the onset of stomach aches. Again, the therapist is called on focusing the work on both the physical and the psychological level: the side effects of drug treatments are handled through gymnastics and massages, while, by means of psychotherapy, an emotion management program is started in order to prevent the patient from somatizing her mood swings and her affective disappointments. Fortunately, soon the situation improves: the hematologic tests taken at the sixth month show excellent results, and, I.T. begins to have a regular menstrual cycle after a six-month suspension. Massages help the patient to let herself go also on a psychological level: the relaxation is so complete that I.T. often surrenders to sleep. Thanks to the now acquired pain reliever techniques, at the sixth month, the new bone marrow aspiration can be smoothly and successfully performed.

The third phase of the therapy (from the seventh to the thirteenth month) is characterized by the consolidation of the psycho-physical results obtained throughout the previous months. The menstrual cycle is regular, massages and exercise continue to be extremely beneficial and the patient now has enough energy to stay away from home for several hours. And with that comes the decision, taken together with the therapist, to further lower the dose of cortisone to 5 mg and to intensify the frequency of meditative practicess (from two to three times a day); furthermore, I.T. starts to engage herself in new activities such as a course on the use of the Internet. Nonetheless, the reduction of cortisone is not easy to manage: besides the return of articular pains, the patient goes through a slight depression phase. At this point, the therapist introduces the use of "laughter therapy": watching hilarious movies and situations helps the patient to relax and focus her attention on non-paranoid thoughts. At the end of January, the patient achieves the complete elimination of cortisone doses: inspite of the small depression, the positive effects arising from the absence of the drug act as catalysts for the positive reactions of her psyche. As soon as the swelling is gone, I.T. begins to joyfully regain her own physicality; the quality of her sleep further improves; her self-esteem grows also thanks to the small social accomplishments (such as the nights out with her friends). The construction of self-esteem and self-confidence, as well as confidence in the path taken so far, is now a building resting on solid foundations: at the thirteenth month of treatment, the patient regularly drives, she no longer takes either sleeping pills or diuretics or cortisone, she has a regular menstrual cycle, she goes out with her friends on a regular basis and she both plans and takes part in relational activities at various levels (from the holidays with her sister to her participation in a fund-raising event for a charity). Today I.T. is in complete remission from the disease and she lives a regular life free of fears in all domains.

The inner path

I separated from my husband and, six months later, I was diagnosed with chronic myeloid leukemia. When the therapist who was treating me came to know about the disease, she decided to terminate the relationship. The articular and muscular pains were unbearable and I just could not accept my new physical appearance (due to the itching caused by the drugs, I ended up giving myself wounds on the limbs, moreover, in order to reduce the excess fluids, I took a lot of diuretics that often caused me fainting): I had put on fifteen kilos and I was really swollen. I couldn't sleep at night because of constant aches and the depression that was by then in place: I took a huge amount of sleeping pills and I spent most of my time in bed, confusing day with night. Nevertheless, in spite of everything, one thing had never failed me: the desire to continue to live, or rather, to live more than before.

I started treatment with the doctor: the beginning of the path included, besides the interviews, autogenic training for pain management, meditation and plenty of physical exercises. I felt ready to start over, I was beginning to realize what was the underlying cause of my disease: as a matter of fact, I had problems in letting myself go and I mismanaged my relationship with life and birth in general. Right from the first sessions of meditation, I started to feel more energetic: I reduced the sleeping pills (partly replaced by relaxation exercises), my inner discipline was rising and I had a strong desire to know all the details of my situation. Thanks to meditation, massages and gymnastics I gradually lowered the doses of cortisone and sleeping pills; almost immediately, we were able to mitigate the pains thanks to a number of active desensitization exercises, by means of the shift of consciousness technique. The results of the hematologic tests gave me a further boost for the next phase of the therapy: the disease was in partial remission. Soon I began to let myself go completely (I even stopped taking sleeping pills) and to accept my body and the drugs I was forced to consume.

Unfortunately, on the day of the bone marrow harvest I failed to implement the consciousness-shifting technique that I had been taught. It felt like falling back in the dark: all my fears reappeared, I sought refuge in sleeping pills and my willpower wiped out. We patiently resumed our work, until I was again able to fully confide in the doctor, to regain my independence and to manage my emotions. I was doing all the exercises prescribed for my psycho-physical wellbeing, supported by the strength of my will and an enhanced self-awareness, then the time for the next bone marrow extraction came. When I read the results of the tests, I was bewildered: they were perfect. No anomalous cells could be found in my marrow. I began to see life through different eyes: colors started to appear, my concentration was increasing, and my physical, psychological and immune resistance kept improving. The pain and inflammation had decreased, but they were still bothersome (by then, I was dependent on cortisone and I was scared of quitting it). Therefore, we focused our work on will and we began to practice new meditative techniques aimed at soothing the pain. The quality of my life was getting better day after day: I managed to stay away from home for several hours, I devoted myself to small tasks that distracted me, and depression faded out. Soon I was able to eliminate the cortisone (in spite of all the problems related to abstinence): these results strengthened my self-esteem and provided me with the compelling incentive not to give up, even in the worst moments.

Both blood and marrow tests showed flawless results, moreover, I began to master the techniques of pain desensitization. This uninterrupted flow of positive results gave me an edge: I managed to go to the seaside with my children, I returned to drive, I started to go out with my friends and there were outstanding improvements in my own capability of thought processing which I before perceived as blurred. By that time, my life had changed dramatically: I had no more aches, I liked myself physically and also my approach toward the male world, from which I formerly felt the need to escape, underwent significant progresses. I had come to acquire a new consciousness of myself and my body, I had learnt to say those no's that I would have never even dreamt of pronouncing. I was totally reborn.

8.5 Case 3: the I.M. case

The patient I.M., aged 32, comes to our laboratory eight months after she learnt to be suffering from chronic myeloid leukemia. From the very beginning, her psycho-physical situation appears as highly problematic, due to the disease and the use of chemotherapical agents: the patient is affected by severe bone aches, she is swollen, she put on considerable weight and she is in a clear state of depression. The earliest sessions already start to show the likely triggering event: the unprocessed grief related to the separation from her partner.

The clinical path

The treatment of I.M. Immediately promises to be a particularly complex task: on the one hand, an extensive psychological work must be undertaken to help the patient to face her disease, to remove its causes and contributing factors, to deal with possible future scenarios – a transplant but also the possible deterioration of the situation. On the other hand, I.M. has an immediate need for "physical" assistance: first, it is essential that the disease does not degenerate otherwise a transplant would be just unthinkable; second, the aches and pains caused by the illness and the drugs that treat it are straining the patient. The first phase of the path (from the first to the fourth month) is marked by the contributions of different techniques. The interviews with the patient are focused on operating on the emotional states and the behaviour that correspond to the causes (i.e. the grief) and the contributing factors (i.e. distortion of reality, conditionings, wrong relations) of the onset of the disease. The methods of pain desensitization help I.M. not to feel pain any more during the bone marrow harvesting and bone biopsy. The frequent practice of plexus meditation and of visualization techniques (at least two or three times a day) is directed at avoiding the degeneration of the disease and to gradually restore the patient's psycho-physical balance. A few weeks later, the work carried out during the interviews and talks with the therapist is coupled with the assignment of a task to the patient, namely, she is required to keep a diary to record her emotions and moods. The therapy produces beneficial effects on all levels of intervention: I.M. is less swollen, her hematic parameters are stable and she regains a good physical stamina (she reduces the number of daily hours of sleep from 14/16 to ten). An examination of spleen, liver and kidneys shows only the spleen enlargement by one centimeter. Unfortunately, a suitable donor has not been found yet and the chances of a successful transplant diminish.

The second phase (from the sixth to the eleventh month) is characterized by an irregular pattern in many respects: the therapist-patient relationship, the hematic tests, the psychological situation. The professional sphere represents a problem common to seriously sick persons: the company I.M. works for (and where she holds an important position) asks her to resign from the job. The patient's reaction is completely negative, as she feels "useless", and this has repercussions on her hematic parameters which deteriorate considerably in the sixth month. Hence, therapeutic efforts are mainly directed at repairing the damage and at starting to rebuild the self and self-esteem: meditation is practiced even five times a day and the interviews with the therapist focus on emotion management and personality reconstruction. After an initial improvement, the patient's final withdrawal from work sets the clock of the situation of I.M. back to the beginning of the month. The therapist responds to this new adversity by organizing a real retirement from the world: for two days, the patient must abstain from food and meditate, no contacts with the external world are allowed, except for the therapist. Besides producing significant short-term results (the improvement of hematic parameters), this experience is beneficial to I.M. to develop will strength and discipline. At the end of this retirement, the situation seems to turn to the better: meditative techniques coupled with a diet rich in antioxidants and regular physical activity, lead to a marked improvement in her parameters. And more than that, the patient regains her ideal weight, her skin tone becomes healthier and ovulation (that had stopped more than 10 months before) returns. Therefore, the fact that it is precisely the therapeutic bond to fall into a crisis over the following two months is almost startling: the patient is recommended to employ the techniques she has learnt, but the therapy is nevertheless suspended. At the end of the eleventh month, the blood parameters (platelets, in particular) are slightly worsening. The following month, the patient returns to therapy.

The third phase of the path of I.M. is undoubtedly the most challenging one. After two months of treatment with interferon (throughout this period we focus on minimizing side effects), the news of a possible transplant unhinges the therapy. Again a twofold work is required: on the physical level, to help the patient to endure the pains and the interruption of interferon, and on the mental level, to prepare her to the new prospects opened by the transplant. The therapist conducts a few sessions with the mother of I.M., who will support her in the transplant (which will not be executed in Europe): of course, phone assistance and availability throughout the period spent abroad are no less than total. The pre-transplant period is two and a half month long and it is marked by both successes and failures. At first, the physicians found I.M. in an excellent psycho-physical state (considering her disease): a lung examination shows a lung capacity 30% higher than the average and an adequate level of arterial oxygenation. Hematic parameters are altered, but not spectacularly, which comes as no surprise given the stressful situation. Her heart is in good health and body temperature remains constant. At this stage, the therapist's advices mainly address the mental and emotional attitude of the patient (besides the obvious continuation of the pain-relief practices): the therapy proceeds through e-mail on a daily basis, I.M. intensively practices meditation and she devotes herself to relaxing, stimulating and even ironic readings. Unexpectedly, the following month sees the interruption of the transplant procedure: hematic and bone marrow values seem to no longer fall within the parameters established by the transplant protocol. The doctors decide to treat the patient with a month of Imatinib to bring those value into the correct range: the therapist has no time to lose as she must mentally prepare the patient to react to this inconvenience. The values go back to normal in a month (and without the contribution of Imatinib): the stage is set for the transplant which is performed after two days of chemotherapy (one hour a day) and four days of radiotherapy (three times a day, twenty minutes per session). The implementation of the techniques learnt throughout the therapy plays an essential role in these days: the expected loss of blood in the urine does not occur, nausea and dysentery are limited. The preparation to the transplant itself is carried out by phone: the focus of the therapy is directing I.M. towards the acceptance of her new marrow. No clinical complications are registered by the doctors and the course of the procedure is surprisingly good: only initially, the patient is administered with a low dose of morphine to ease the pain. The days after the transplant are spent doing a bit of physical exercise (walking in the corridors of the hospital), playing cards or chess to keep the mind sharp, watching funny movies and, of course, continuing to practice meditation. After the transplant, the doctors consider that there would be concentration difficulty and a reduction in memory functions, but in the case of the patient, none of these effects is encountered. She begins to eat autonomously and to regain good physical vigour ahead of schedule. After only 20 days from the bone marrow transplant, all medicines can be taken orally. Despite a few side effects (easily dealt with) of a new drug (called growth factor) that she has to take in order to stimulate the activity of the immune system as a whole. and the lack of clarity on the outcome of the procedure (at first, it seems successfully accomplished, but later a few doubts start to emerge), I.M. nonetheless maintains her balance and a strongly positive attitude. The following month, the doctors ascertain that the transplant has not been succesful: twenty months have elapsed since the beginning of the common trail and the therapist is again called on to support the patient to accept the failure and to reconstruct a normal life.

Not everything was vain in this journey: although the transplant did not prove resolving, the path she covered gave I.M. a lot. Once back to the country, the primary goal is to reinsert herself into a life as normal as possible, maintaining a positive psychological attitude and continuing to work to arrest the disease. It is considered convenient to couple the therapeutic work with a pharmacological protocol based on Imatinib: the acceptance of the situation not only implies her giving herself some chances of recovery, but, perhaps most importantly, it also brings about the first steps towards adjusting to a radically different life. After only three months since the transplant failed, I.M. can get back to work. The drug Imatinib and the personal progresses achieved over the months we spent together allow the patient to be reinserted into a fully normal life. In the following months, her hematic values stabilize on good levels: the disease shows no sign of acceleration; I.M. got married, thereby achieving her return to a full emotional life; meditation is a natural discipline and she is continuously assisted by pain-relief techniques in the periodical examinations to which she must subject herself to check her health condition. After several years since the therapy in our laboratory, I.M. continues to exhibit a perfect psycho-physical balance.

The inner path

The end of the relationship with my boyfriend was a knock-down for me, a grief that I failed to accept. I began treatment with the doctor six months after I was diagnosed with chronic myeloid leukemia, and already waiting for a transplant. In the first part of the therapy, we focused both on processing the grief and on the desensitization to the pain caused by the disease. The implementation of consciousness shifting techniques enabled me to deal with the several tests and bone marrow harvestings to which I was constantly subjected. I began to meditate several times a day, focusing my attention on raising my immune defenses and on swelling, thereby achieving excellent results. I started to keep a diary that would prove extremely useful in the subsequent analysis and elaboration of those emotions that might be harmful; I began to become more aware of my own Self and I equipped myself with an energy that I previously did not possess. Despite the improvements that I had struggled to achieve, luck did not seem to be on my side. I was fired from my job, which resulted in greater insecurity: I had to spend two days in silence, fasting and meditation to restore the balance of blood parameters. In the meantime, the possibility to find a compatible or semi-compatible donor seemed an outside chance.

When I was reached by the news that a donor had been identified, I was in such a state of mental and physical balance that I was terrified by the idea of starting a burdensome path all over again: I was hesitant to accept the transplant, but I finally opted for it. The intervention had to be preceded by a long and painful period of tests and chemotherapy, but I could manage all this thanks to the relaxation meditation techniques and the consciousness shifting technique that I had come to learn during the therapy. Unfortunately, I was suddenly troubled by another bereavement: the suicide of my brother. The doctor helped me to quickly overcome the trauma, as I necessarily had to focus on the transplant: we managed to stabilize hematic values and to maintain a good mood, despite of everything. The day before the procedure, I prepared myself to receive the new marrow as it belonged to me already: I was well-prepared, calm and I confided in the positive outcome of the transplant. Unluckily, not long after, the doctors conveyed me the unexpected news that the transplant had been unsuccessful. I was beginning to embrace a new way of living life, marked by the positive acceptation of the outcome of the intervention and the control over the disease. From a medical point of view, the clinical situation had neither improved nor deteriorated; as far as my own body is concerned, I had learnt to handle pain. From a psychological standpoint, I had been able to reach a certain balance with myself and my emotions and I began to direct my concentration to those healthy cells that were multiplying without getting sick. I learnt to live with greater intensity and depth so that also all the other aspects of life resumed their course: I got married and I returned to work. Now I got to hematologic remission, but not cytogenetic remission. I continue to make use of the consciousness shifting techniques during marrow extraction, thereby managing to feel no pain. Meditation has become a discipline that I absolutely don't want to abandon. I can say I am finally satisfied with my life.

8.6 Case 4: the M.O. case

The patient M.O., aged 41 , arrives to our laboratory after she has been diagnosed with a lumbar cancer, a lung cancer and a brain cancer. Since the diagnosis she has been treated with Gefitinib, a drug that allows her to enjoy a state of physical health more than good considering the diseases she suffers from. Nevertheless, her state of psychic health is not at the same level: after the diagnosis, the patient has given up many of her occupations, coming to abandon, among other things, the sport she highly cares about.

The clinical path

From the very first encounter, a major couple problem emerges: in fact, the patient's marriage is in crisis due to the lack of children. An abortion at the fifth month, after years of attempts, caused her a permanent trauma and a sort of rupture in the relationship with her husband. Throughout the first phase of the therapy (the entire first month) the therapist seeks to reinstate a first level of stability in the patient's psyche: the interview sessions are mainly focused on the problems of the couple, while meditation (with the aid stemming from M.O.'s predisposition) is designed to restore stability and confidence. The psycho-physical picture slightly improves: now it is easier for the patient to fall asleep and her conditions remain good.

In between the second and the third month, the patient's relationship with her husband begins to change as she has stopped arguing with him. She continues to progress in meditation: by the third month, the patient already masters heart, pineal gland and throat meditation. She begins to follow a diet based on antioxidants. This situation of (relative) calmness enables her to start to undertake the work on the causes of the disease: engaging in this process of clarification with her husband enables the patient to let emerge her trauma resulting from the disappointment expressed by her partner over the abortion. The patient's psycho-physical status appears further improved: her sleep is good, both in terms of quantity and quality, and so her appetite and mood. The patient meditates with pleasure, for such practice improves her sense of wellbeing; step by step, she is reconstructing the relationship with her husband.

At the fourth month of the path, which so far has been extremely positive, the therapist starts to address with the patient the concept of "retrieval" of her hobbies: inasmuch as a general state of well-being seems to persist, it is possible to gradually restore her life to normal also in this important department. Therefore, M.O. resumes her sport activity (alpine skiing, which she had abandoned for over a year) and she begins to practice yoga. Her sleep further improves (up to 8 hours per night, two more than in the previous months) and the blood tests taken in the fifth month showed no tumor markers: the following month, she would have to have a CAT scan. M.O. continues to engage herself in meditation and she learns new practices (i.e. "empty mind"); at the end of the sixth month of the therapy, she communicates her desire to return to work: hence, it is precisely on this issue that the interviews are focused. The CAT can reveals a reduction in the tumoral bulk, both in the brain and the lung.

At the seventh month, M.O. goes back to the work world: her psycho-physical conditions are now stable enough to allow her to lead a normal life in all everyday situations and events, be them personal, relational, professional or sports. Hence, in the following month, the new crisis with her husband comes unannounced. Nonetheles, throughout all this, the patient maintains a very positive attitude: despite all the discussions, she deals with every occurrence with an excellent control over her own emotions and thoughts. Not only these events do fail to destabilize her, but they neither have any impact on the couple that regain their balance in a few weeks. New tests (tenth month) show negative tumoral markers and also the last CAT scan reports encouraging results. After a month break from the therapy, the patient returns to the therapist to assess the stability of the results achieved. In the meantime, she has been seen by a specialist who expressed a negative opinion on the necessity of surgery, which is no longer needed. The latest examinations showed no sign of brain cancer, reporting the presence of tumor cells only in the pelvis. M.O. continues to be in more than good physical condition: she practises sport on a regular basis, she maintains a controlled diet and her sleep is still deep. The relationship with her husband, although generally good, is still affected by minor problems that nevertheless do not compromise her balance. Her work proceeds regularly and the patient feels completely satisfied with herself and her life.

The inner path

At the time of my first encounter with the doctor, it seemed I was close to death: I had been diagnosed with three tumors, namely a lumbar cancer, a lung cancer and a brain cancer. However, the drug I was treated with enabled me to lead a decent life: my appetite was good, my menstrual cycle was regular and I had attempted to get pragnant for many years, but unsuccesfully: this had casted my marriage into a crisis. When I had finally got pregnant, the fifth-month abortion caused a huge shock for our couple life. Prior to the diagnosis, the ony moment of peace and relaxation I could enjoy was given by my great sports passion: alpine skiing. After the diagnosis, the darkness: I was scared of doing anything, including what I was most fond of.

The first issue to address was our couple problem: I started to keep a diary and to change the concepts I had come to relate to the traumatic emotions experienced in the past. I began to engage inmeditative techniques with the visualization of the first plexus (i.e. the sacral plexus): a red energy center that is located at the base of the vertebral column and irradiates energy into my bones, muscles and the circulatory system. This technique brought about immediately evident results: CAT scan showed regression of tumor masses, and there was not a trace of the disease-related distress in my dreams. The relationship with my husband was improving and I was beginning to accept my past. We pursued meditation, focusing on the second plexus (i.e. the genital plexus): an orange energy center, which is located right above the sacral plexus and appears as a desert of warm and silky sand. Consciousness leaves footprints on the sand and becomes one with the echo coming from the horizon.

The phase of lake meditation opened me new perspectives: suddenly, I realizaed that the inception of death within my body had been triggered by the immense disappointment with my husband. In the earliest days I was practising heart meditation, I was affected by an unusual lung pain; during the visualization of the throat plexus, I experienced a sensation like a "strong opening". Meditation was accompanied by the radical resumption of my passions: I was no longer afraid and I felt the need to reinfuse my life with meaning. After all, things with my husband were improving: we were more able to open ourselves to each other and we had mutually forgiven a considerable part of past mistakes. Forasmuch as I had nearly overcome the fear of disappointment and failure, again, I underwent CAT scan with excellent results that furthert enhanced my strength and confidence: the tumor masses in the brain and lung had dramatically shrunk. By then, meditation had become indispensable to my life, as well as the constant search for balance and the practice of my favourite sport. I felt completely changed, healthy: the negative attitude I used to have towards life had given way to an outstanding optimism and an excellent relational ability that I had never experienced before.

Now that my psychic life had changed, it was time for me to focus more specifically on the purely physical recovery. Thus, the doctor and I engage in a new meditation technique: the visualization of tumor cells (first on the lung and then on the sacral area). During this particular meditation, I experienced the continuous elimination of large amounts of catarrh; the subsequent CAT scan reported the complete disappearance of the lung tumor. Therefore, I went on with the "bombings", until, just as I often happen to see during meditation, only the cells in the pelvis remained altered. By that time, I was feeling serene: out of three tumors, only one (and, what's more, in regression phase) was still there.

8.7 Case 5: the A.L. case

The patient A.L., aged 43, comes to our laboratory with psychological and behavioural problems: he suffers from strong addictions (women, gambling and, most seriously, alcohol dependence) and he has a very controversial relationship with his wife, by whom he feels caged up: the more she asked him to account for his actions the more he escapes seeking refuge in his bad habits. The vicious circle shows no sign of breaking.

The clinical path

A.L. Is not affected by particularly serious situations of psycho-physical disorders, rather, a series of wrong choices and previous problems led him to end up trapped in a network of problematic interpersonal relationships. The first remedy for this problem is that confidence no one before the therapist has been willing to grant him. This attitude paved the way for the whole journey: after the first session, the patient is already able to reduce the consumption of alcohol and he agrees with enthusiasm to continue the treatment. The work of introspection, which has been initiated right from the start, reveals a profound disappointment that originated in the family context and underlies all of his problems. Moreover, the beginning of the therapy marks no improvement whatsoever in the relationship with her wife, as she feels excluded from his individual path. He undertakes the learning ofmeditative techniques and the practice of yoga: the patient needs to strengthen his will. For a few weeks, the situation stabilizes: the relationship with her wife is still tense, but the other aspects of the picture undergo step-by-step reconstruction. Alcohol has already almost disappeared from the patient's life, the relations with his two daughters have returned to be satisfactory and the acquisition of the subsequent levels of meditation occurs naturally and smoothly.

The start of the second month of therapy sees further improvements in the patient's conditions. His friends confirm they have noticed significant positive shifts in his attitude, and his wife finally seems to be accepting all the work he is doing on himself, although she admits she doesn't fully trust him. A.L. no longer drinks alcohol and continues to succesfully practise yoga and meditation. The following month witnesses a continuation of this positive trend. Over the sessions, the patient has become much more introspective and he enjoys both meditation and the analysis of his own Self; he fruitfully confronts himself with the readings recommended by the therapist and together they examine his reactions to them. His life continued to ameliorate: the relationship with his wife has regained a substantial degree of affinity and a few minor inconveniences at work (some divergences with his employer) do not undermine his attitude and his awareness. Before the path may be qualified as accomplished, A.L. has to learn the final phases of meditation, namely, the plexus of the throat and the pineal plexus. Four months later, the attainment of balance can be considered complete.

The inner path

When I decided to head to the doctor's consulting room, I wasn't exactly what you would call a strong man. I suffered from severe addictions of any kind: I loved drinking, I felt totally caged and judged by my wife. The more she accused me and questioned me about my conduct, the more I felt the urge to escape from any situation and I resorted to the only form of consolation available to me, that is to say, alcohol. The doctor immediately managed to make me feel better by giving me that credit that I was unable to find in both my relationships and myself. She believed in me and in a short time I found myself free from the need to lie or to outdrink. After a few sessions, I realized that most of my problems stemmed from my family of origin: my father never kept his word, on the other hand, my mother had nver been very understanding. We undertook the path of meditation, coming to visualize, one after the other, the six plexuses of the body. At the beginning, I had to face some difficulties, but later I became aware of my predisposition: my psychic and physical conditions were visibly improving after each session.

Although I had achieved a greater self-confidence and I was less preoccupied with others' opinions, the problems with my wife persisted throughout the first period of the therapy: she was feeling locked out from my path and she was unable to accept it, moreover, she had no confidence in the change that was so clearly occurring within myself. After a few weeks of meditation and interviews (coupled with yoga to address my constant back aches), my lifestyle underwent a dramatic change. I also rescued the relationship with my daughters: with the eelder I managed to establish a closeness that we didn't know before, while, with the younger, I reached a greater harmony. I didn't drink any more, not even a drop of alcohol: my usual swelling was gone and my behaviour significantly changed; even the friend with whom I used to spend my time soon noticed the different. I became more introspective, and in doing so, I felt a certain pleasure. Furthermore, I sensed that several facets of my personality, which had remained dormant for years, were beginning to emerge and take shape. The relationship with my wife soon acquired considerable stability, since I was able to maintain a fair control over my emotions: I no longer felt any urge to escape when confronted with any sort of problems. My new way of being was, almost simultaneously, reflected in my physical appearance and behaviour: I began to take care of my outward aspect, I became strong and markedly extrovert. In short, I felt totally renewed; at times, even presumptuous.

[72] *Studies on meditation.* Prior to the Seventies, there were only very few scholars who scientifically investigated the benefits of meditation. Western medicine has paid scant attention to this discipline until a young physiologist, Robert Wallace, demonstrated that meditation, beyond its spiritual implications, has profound effects on the body. In a series of experiments begun in the late Sixties, Wallace analyzed the different bodily functions of a group of volunteers, mostly college-age, while they were practicing meditation. From a subjective point of view, the kids experienced an increasing sense of calm and inner silence. Against all expectations, the subjects achieved a state of deep relaxation and significant changes in respiration, heart rate and blood pressure at a surprisingly quick pace. From the year 1978 onwards, Wallace has devoted his researches to the effects of meditation on ageing, identifying three parameters to assess overall biological ageing: systolic blood pressure, near vision and hearing threshold. Wallace showed that the practice of meditation yields positive long-term effects on all of these three parameters, thereby "reversing" the ageing process. Wallace's study revealed that meditators, who had regularly practiced meditation for less than 5 years, exhibited an average biological age of 5 years less than their chronological age; while those who had meditated for more than 5 years had a biological age of 12 years less than their chronological age. Furthermore, as it should be pointed out, the research gave similar results both for young and older subjects. An insurance group has recently conducted a study aimed at evaluating the overall health state of two thousand meditators who exhibited enhanced health in all age groups: these subjects have resorted to medical treatment half as frequently as the control group. Meditation has been found to have a remarkable impact on the probability of developing a variety of serious diseases: particularly striking are the data on the decline in heart decline (80% less than in the control group) and in cancer (50% less). As we often repeat, the body is constantly engaged in the complex task of preserving a delicate balance in its own biochemistry and in the harmonious operation of its various parts. When a disturbance occurs, it may cause illnesses and ultimately death: this is why the body's ability to "self-maintain" its own health is of the utmost importance, we define such ability homeostasis. Therefore, the results of the aforementioned researches have showed that meditation is a powerful tool to stimulate faster homeostasis. Since the early Nineties, in addition to the CAT (Computerized Axial Tomography) scan and the PET (Positron Emission Tomography) that were respectively introduced in the late Seventies and Eighties, the studies on

meditation have benefited from technological development as scientists have been able to acquire new valuable data. As revealed by several studies carried out in various institutions around the world with the use of electroencephalograms, meditation does possess the ability to synchronize the patterns of the two cerebral hemispheres. It has been shown that individuals who exhibit a higher degree of synchronization between the two hemispheres also enjoy a better psychic health status; on the contrary, strong imbalances are signs of instability and stress. The advent of sophisticated neuroimaging techniques, such as rCBF (*Regional cerebral blood flow*) and FMRI (Functional Magnetic Resonance Imaging), has allowed research to achieve previously unimaginable results as these tools enable scientists to observe the dynamic operation of the cerebral apparatus. Since 1987, the *Mind and Life Insitute* has conducted meetings and researches aimed at integrating Western knowledge with the wisdom of Tibetan culture in a union that involves some of the most prominent figures in this domain including the Dalai Lama Tenzin Gyatso, Daniel Goleman and Richard Davidson. In 2001, this close collaboration, marked by the contribution of expert monks, led to discover that the Buddhist classifications of the various meditative disciplines are not only related to cultural and religious aspects, but they also have staggering neurophysiological equivalents: data show that the practice of the different meditative techniques involves the activation of distinct brain areas, thereby making each type of meditation a unique experience. The eighth meeting organized by the *Mind and Life Insitute* was focused on "The Science and Clinical Application of Meditation". This is undoubtedly a topical theme in the United States where mind-body techniques are widespread and where recent studies have demonstrated that such techniques can, in most cases, lower the costs for health insurance by reducing both the period of recovery from surgery and the administration of certain drugs for hypertension. It is becoming increasingly clear that meditation is an irrepleacable tool to discover, study and take advantage of the relationships between our mind and our body.

Essential bibliography

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Wallace Robert , *Neurofphysiology of Enlightenment*

[73] *What is meditation*? For many years we have been extensively using meditation in a clinical setting for appropriately selected patients, and we have been able to study numerous cases, providing evidence of its effectiveness in reducing tension, anxiety, guilt and various stress-related alterations such as insomnia, stutter, high blood pressure, abnormal heart rhythm and even in improving the physical and psychological status of patients with cancer. We have verified its efficacy in breaking addictions to alcohol and smoking, promoting a sense of personal identity, improving mood, facilitating the expression of emotions, enhancing creativity, vitality and overall performance. However, clinical studies indicate that meditation is not suited to everyone: its succesful implementation requires the individual to possess a certain degree of self-discipline. Meditation must be studied, also in its theoretical dimension, in order to comprehend its underlying laws. Not only does meditation act on one's vision of oneself, but it also affects one's conception of the external world. What is experienced is a real shift in perception, namely a change that opens us to the environment, thereby increasing our awareness of nature's beauties and colors, of others' joys and pains: the very fabric of life is perceived. But beware! Each individual experiences and savours different levels of sensations both innerly and in relationship with others who practice this discipline. It is strange how seldom we stop to reflect on the existence of this slippery "I". Who is this person who resides within us and relates both to our external and the internal world? Where does it come from and where does it go to? It is undoubtedly alive, but then what is really life? What is this weird, magical, frustrating thing which enrages us, which finds its own expression within us, which most of the time compels us to an awkward balancing act between joy and sadness? But if we think about it, how could it be otherwise since who we are is us and it's us to have experience of that. Can we denote this I or the Self, whose nature we'd like to understand, by the simple word "mind"? This is a useful generic term that refers to the contents of the inner world, whether conscious or unconscious. The mind is: our thoughts, feelings, memories; it is what we see, what we feel, the sense we attach to the outside world, our being aware of our own existence, dreams and hopes for the future, our morals, the set of values to which we adhere in every aspect of our life, our expectations and requirements both for ourselves and for others. The mind is also genetics, biology; it is our whole being. It simulatneously encompasses profound and concealed ramifications, lower levels of awareness that can deeply affect our thoughts, actions and emotions. The mind is the magical inner theater where the plot of our life is played out; just as in any

theater, the action is both on stage and behind the scenes; there are both the actors and the playwrights, the conscious mind that thinks and is aware of its thinking and the unconscious mind that secretely acts in other manners. To know ourselves, thus to know who we are, is to know our mind in its various levels of consciousness, thereby becoming knowing mind and known mind at the same time. Meditation leads the individual to a profound self-knowledge to the point of displacing this "I" and becoming "unlimited". In meditation, the mind first opens up to the preconscious: that set of thoughts and memories that immediately crowd our mind when we try to turn to our inner selves. Then, as the ability to meditate is enhanced, the mind opens up to the unconscious. At first, there may arise memories long buried in the personal unconscious, and, only at a later stage, there emerge the universal symbols and archetypes from the collective unconscious. During meditation, the mind moves from the particular to the general, while the state of concentration leads the mind to depart from the general to arrive at the particular. Therefore, the mind employs a symbolic language. Clinical therapy avails itself of symbols that are able to evoke in the patient a state of psychophysical transformation that induce self-healing: such symbols are the keys to the unconscious letting those inside out and those outside in. Meditation takes us from the rational, linear, logical world to the depths of an abstract world made of symbols and metaphors and where truth appears in the form of intermittent flashes of perception, giving rise to profound changes in our way to deal with experience. Hence, a reasonable answer to the question "what is meditation?" should avoid any mystical or transcendental definitions: one possible answer is indeed that meditation is "a way of being", namely a fundamental tool enabling us to know ourselves in order to be ourselves with no fear. Meditation allows us to have experience of what lies behind the many thousands of thoughts and emotions that normally crowd our lives; it is the ability to order, discern, discard, enhance them; it is the gateway to our brain's faculties, the path to greater freedom, the liberation from social conditioning, a good training for longevity. Although a considerable part of psychological studies has relied on methods based on physiological parameters, it should be borne in mind that any two physiologically similar individuals may exhibit different causes for relaxation, thus they may go throgh extremely dissimilar experiences: one might dream about something, whereas the other might keep a clear and steady focus on her own respiration. In any case, meditation does undoubtedly predispose the individual to a state of "physiological calmness", namely an ideal condition to travel over the way of introspection and to trigger those self-referential mechanisms thatmost probably underlie the healing processes and those of psychophysical wellbeing.

9. The Operation of the Mind

Our approach rests on the conviction that human mental activity can be represented through a model. But what does this exactly mean? To simplify matters, but not too drastically, we may say that all of our thoughts can be expressed by means of a mathematical/symbolic language, in a manner equivalent to that we use to describe and predict a planet's trajectory, to analyze the shape of radio waves or to identify the melting point of a substance. The fact that the operation of our mind can be explained by a model is accepted by nearly all the scientific community. The philosophical dispute is rather focused on the boundaries to the applicability of this concept[74]. Some argue that there are no limits of applicability, namely, any thoughts or mental activity of ours would be representable in a mathematical/symbolic form. Others assert that certain mental activities will never be formally describable.

Accepting the possibility that our thoughts can be formalized into a model is just the first step towards the comprehension of human mental processes. The hardest part obviously comes with the attempt to define the critical features of the model. Also this one is a frontier topic of modern science, and, as it is always the case with unexplored domains, it is the object of many high-pitched disputes among researchers. When a software based on our model makes good predictions, when it efficiently stores data or when it is capable of self-diagnosing, and possibly of correcting, errors, then it means we have attained some small intermediate goals. When the treatment protocols based on our models are applied to oncological patients and we register a significant increase in both the quality and quantity of their lives, then it means we have attained a remarkable intermediate goal.

The fundamental notions underlying the representation model constructed in our laboratory are two. The first idea is that any human mental activity can be represented in a multi-dimensional space characterized by the simultaneous presence of various factors, all potentially measurable. To put it in simpler terms, any decisions of ours is determined by a certain number (large but not infinite) of concurring factors. The interesting thing is that all these factors are potentially identifiable and measurable. Hence, it follows that, through appropriate procedures, it is possible to come very close to the knowledge of the extent to which the diverse decisions are affected by each single factor[75]. Over the last decades, there have been considerable advancements in the measurement of the so-called irrational variables. The fact that, for example, the consumer decision process in the purchase of a good involves the intervention of not strictly economic factors (such as the voice tone of the interlocutor or the outside temperature) has long been acquired by motivational psychology[76]. It is sufficient to turn the television on and watch the various advertising campaigns to realize how these concepts are very successfully employed in practice.

The second idea underlying our model is the fact that, within each of the various dimensions that compose the mind's multi-dimensional space, there are at least three forces acting simultaneously. These three forces stem from the activities carried out by the logical, the analogical and the realizational parts within each person's mind. By logical thinking, we denote all that human mental activity that we might say, simplifying a bit, is mainly handled by the left hemisphere of the brain. From a functional point of view, we are referring to deductive and mathematical skills. As far as statistics is concerned, we might say that these are more commonly male traits. From the perspective of history, we might state that they found their fulfillment in our Western civilization. By analogical thinking, we mean all that human mental activity that is predominantly controlled by the right hemisphere of the brain. From a functional point of view, we are talking about associative and geometric skills. As far as statistics is concerned, we might say that these are more commonly female traits. From the perspective of history, it might be argued that they found their fulfillment in the so-called Eastern civilizations.

Obviously, any thought, any person and any civilization will always be both logical and analogical at the same time. When we state that, from a statistical standpoint, a woman tends to be more analogical than man, we purport that her mental processes are often characterized by a more pronounced development of the analogical part with respect to the logical one. When we assert that the Western civilization is more logical than the Eastern one, we mean that the resulting culture (i.e. language, alphabet, methods of inquiry and discovery, etc...) has been shaped mainly according to deductive-sequential criteria rather than associative-analogical ones. From a graphical point of view, we believe that such concept is easily understandable. If we describe a person's mind by means of a Cartesian space where the X-axis represents the analogical component (i.e. horizontal dimension) and the Y-axis represents the logical component (i.e. vertical dimension) we will produce an array of elliptical geometric shapes. A person whose the logical part were perfectly balanced by the analogical component would be represented by a circle). As a curiosity, we may highlight that our model shows that a perfect circle is impossible to attain and that the closer a person's values are to the circle the higher such person's mental instability[77].

Each person has a different ellipse representing her mental activities. However, it is interesting to remark that we might group the diverse ellipses into similar categories. Therefore, we will identify the tendentially vertical (i.e. logical) type, the tendentially horizontal (i.e. analogical) type and, why not, the tendentially circular type[78]. Shape characteristics of the ellipse being equal, the larger the figure, the more "intelligent" the person can be considered. Man's cerebral evolution, both in individual and social terms, is a continuous transition to larger and larger ellipses. Such development is mainly fostered by two factors: direct personal experience and the indirect experience that is compounded into technology. This implies that the more a person is able to metabolize experience and technique, the better she adapts to the surrounding environment. In biological terms we might say that she is "stronger", in cognitive terms, we might define her as "more intelligent".

9.1 The models of reference

As we have seen, all our researches in both the domain of psychoneurophysiology and the sphere of artificial intelligence, as well as the respective clinical and business applications, share a common starting point, namely our model of the human mind. Let us begin by defining what we mean by "mind". By this term, we denote the set of instructions enabling our brain to perform. With respect to the analogy previously drawn with the world of computers, the brain is the hardware and the mind is the software, precisely and with no conceptual differences. The brain belongs to the physical dimension of reality (like integrated circuits) while the mind falls into the domain of information (like the instructions of a program). Resorting to another analogy, we might maintain that a cell appertains to the physical dimension of reality and the instructions inscribed in DNA to the dimension of information. As far as their domain of membership is concerned, and from our standpoint, mind, software and DNA are equivalent concepts.

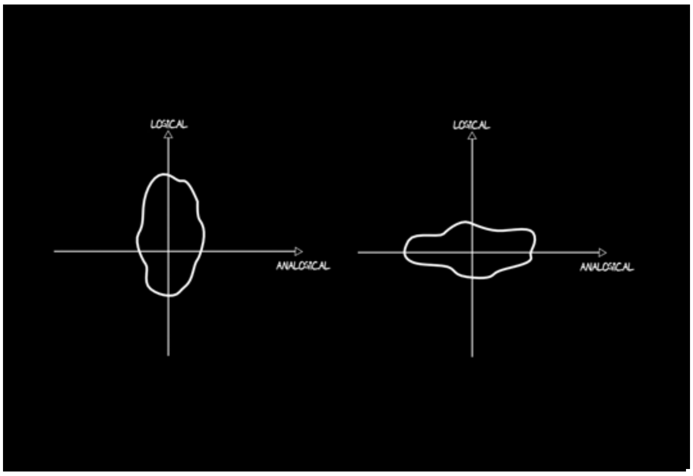

Fig. 9.1. "Vertical" mind and "horizontal" mind.

In accordance with the theoretical proposals of Alan Turing, the initial goal of our researches in the field of artificial intelligence was the construction of a machine capable of conversing with a human being as an equal. For a considerable period, this approach allowed us to limit the extent of our interaction with the external world and, therefore, to focus our computational attention on thought. The first example of software capable of communicating with man and produced by our research laboratory dates back to 1983, roughly six years since the beginning of our journey. After a first initial enthusiasm (following the relative speed at which we had managed to convincingly reproduce the feeling of being dealing with another human being) we realized that such a system would never be able to support a depth of discussion going beyond some ten question-answer iterations. Hence, the primary element we needed was a representation model of the human mind: that was the only way a machine could soundly hope to talk to man on an equal basis. About a decade later, the first model of the human mind, albeit incomplete, was ready. But, of course, that was not enough. Along the way, we came to understand that we also needed a solid approach concerning the very nature of learning and that, if not equipped with the ability to self-perceive, the machine could never evolve beyond a certain point. And this is how a relatively circumscribed objective turned out to be just the tip of an iceberg of huge proportions. It wasn't possible to "simulate" a reasoning, it rather had to be "generated" in all its elements: any of the tricks behind the video, as clever and likeable as they might be, was inevitably discovered by our mind.

According to our approach, the mechanism underlying the operation of the mind is that of the models of reference. A model of reference is essentially a sequence of instructions which is triggered by a specific configuration of data. Resuming the analogy with the world of computers, we might assert that the configurations are the inputs while the actions are the outputs. As far as the analogy with the biological sphere is concerned, we might instead say that the notion of models of reference is very close to that of the stereotyped behaviours[79] resulting from stimulus-response mechanisms. A vast number of models of reference (in part innate and in part acquired through experience) are stored within our brain. Variously combined with each other, these models determine all of our perceptions, thoughts and actions. As pointed out, the models of reference are activated by a given conformation of signals coming from the sense organs (external and internal) which univocally and in a deterministic way initiate their execution. This process occurs at all cognitive levels (conscious and unconscious) and it occurs at all the levels of the Spiral of Knowledge. We presume innate models of reference to be written in the DNA of all living forms. In particular, the genes, besides determining the shape and position of the organs, somehow possess the instructions to memorize the models of reference into the brain. We believe that, for the majority of living beings, some of these models are responsible for the creation of new models which are in turn gradually stored in the respective nervous systems, thereby becoming part of the regular cognitive and behavioural process. Finally, we expect some living forms to be endowed with particularly evolved models of reference such as, for instance, those related to the modules of language, consciousness and emotions.

2 + 2

Let us observe the previous writing and reflect upon how our mind tries to give it an interpretation, namely what are the models of reference we use to move from chaos to understanding. Certainly, we employ the model of reference "Arabic numerals" (activated by the character 2) and the model of reference "elementary algebra" (activated by the sign +). Some of us have automatically extended the writing since they interpreted it as a question and thought about 4 as an answer (perhaps activated by the model of reference "elementary-school-textbook question"). But not everyone has thought about the answer, as the hypothetical question might be considered too abecedarian: things would have been different if we had looked at the writing "97 + 3", and again different in the case of "1.821.723 + 656.992". Let us proceed. We all have used the model of reference "book page". If we had seen the very same writing flashing on a billboard, rather than on the back of a shirt, we would have triggered different models of reference. And what would we have activated if we had detected it inside a stereo-equipment store on an amplifier and four loudspeakers? And what if we had spotted it on a supermarket shelf during a special offer campaign?

Are we done? Not even close. Many of the models of reference we regularly use are so automatic that it is hard for us to make them emerge in a conscious manner. For instance, how many of you are aware of having used the model of reference ”base 10 numbering system”? Yet, it is not an obvious matter. If we had inserted it into the context of a series of hexadecimal sums or, even in binary base (where the digit 2 is not included), the models of reference activated, and thus the resulting responses elicited, would have been extremely different. When we are born we are endowed with a certain number of models of reference genetically inherited from our parents and ready for use. These are the innate models of reference and they enable all the biological functions that are necessary for survival, ranging from eating to crying, from feeling pain or pleasure to learning, from being sad or joyful to sleeping. This holds for us human beings as well as for all living species. It is likely that, “unfortunately”, the models of reference never adjust and therefore that it is only possible to add new ones. Hence, we will have two types of models of reference, namely those of implementation and those of inhibition. For example, if a certain behaviour triggered by a given innate model of reference were found to result systematically harmful, then the mind will produce an inhibitory model of reference in order to counteract the instructions contained within the innate model of reference. At this point, after a sufficient number of iterations, we expect such innate model of reference to be no longer transmitted to our children or to be transmitted only deactivated. Just as it is the case with a physical feature, such as wings or tail.

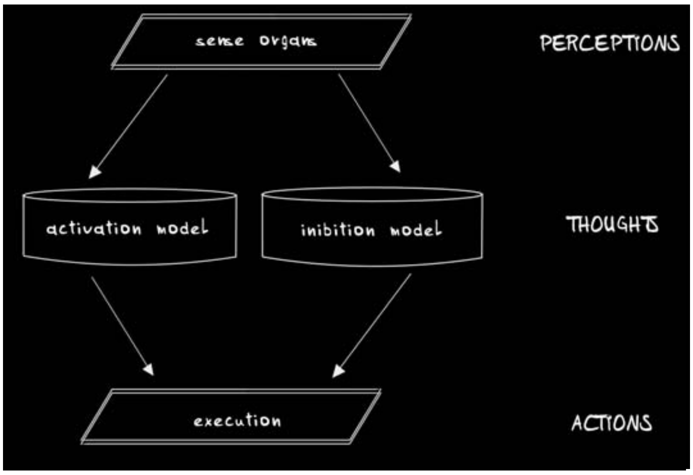

Fig. 9.2. Functional diagram of the models of reference.

9.2 The three basic modules of reasoning

Until 1983, just like most researchers, we focused on the logical facets of human reasoning. Our departure place was the cardinal axiom that thought is essentially based on logic, namely the axiom that a substantial portion of Western philosophy, mathematics and culture used to teach to their diligent students (to be honest, today not much has changed). Nevertheless, this modelling approach proves to be highly inefficient at its first serious confrontation with reality. Most people associate modelling (and hence its computational extension, i.e. machines) only with connotations of "cold logic", therefore it becomes natural to come to a halt when faced with concepts such as learning, creativity, emotions, consciousness, etc...

We have not stopped and we have simply acknowledged that logic is only one of the basic components of the human mind and that logic alone is very far from explaining its functioning. Then, a second dimension stepped in, namely what we have termed analogical dimension. We spent some ten years revising everything we knew about the human mind by adding the analogical component. We moved from a one-dimensional modelling space to a two-dimensional modelling space. It was an extremely interesting path and it brought about significant results in all the areas of our applications. We realized that, from a functional point of view, the introduction of the analogical component enabled us to explain several human behaviours that otherwise would remain inexplicable. The study of this type of behaviours paved the way for the application of the psychoneurophysiological approach to the treatment of diseases. Finally it was time for mind/body relationships to leave the domain of intuition in order to be studied with rigor and scientific method. A further significant consequence of the introduction of the analogical dimension was precisely the birth of the models of reference. Deductive mathematical logic is an extremely valid tool for reproducing the human mind, yet it can be applied only to a small part of our reasoning if employed alone. Therefore, the models of reference emerge as a response to the need to adopt a computational system capable of reproducing also thoughts of an analogical nature besides those of a logical nature.

At the same time as we were including the analogical dimension, we became aware of the existence of a third area, namely what we would later call the realizational dimension. This aspect was put aside for a few years and it would be examined only after attaining a proper degree of confidence in the joint application of the other two. Over the year 2001, the modelling space became three-dimensional and the computational scheme of the "three minds" was refined. Our view is thus that within our mind there exist (at least) three distinct basic modules of reasoning., each with its own specialization and its own associated models of reference. We believe that these modules are involved also at the unconscious levels of our mind, but, of course, for the time being, we are able to identify and analyze them only at the conscious levels.

When we are confronted with a problem, there are basically three different forms of reasoning that enable us to come to a final action/decision. First, we have the "slow" logical path that tends to weigh all the prospects and all the consequences of any possible action we might undertake. Second, we have the "fast" analogical path that relies on the outcomes of our previous actions in similar situations. Finally, we have the "immediate" realizational path that is concerned with anyhow achieving the established goal. The proverbial example of the donkey who died of hunger because it couldn't decide which field of grass to eat from[80] might be useful to begin to grasp the nature of the three modules. According to our framework, if the donkey thought by means of one module alone, say the logical one, it would never find itself in a situation of prolonged indecision because the two choices would nevertheless be different from one another, perhaps only due to tiny differences, for instance the number of the grass-blades or even the mere fact that one field lies on its right while the other on its left. Conversely, if the logical module came into conflict with the analogical one, then a situation of prolonged (and dangerous) hesitation might occur. It is sufficient to carefully analyze our own personal experiences to verify that the actual states of irresolution occur only when we deal with two different paths of reasoning that lead us towards alternative actions. And such clash may become harmfully immobilizing if there are only two options and the two modules are severly in conflict with each other. Luckily, we are also endowed with the third module, i.e. the realizational module, which has the function of making us survive in any case and which, at a certain point, will force us to choose. Ceteris paribus, this third option generally results to be the closest to our primal instincts.

9.3 The emotions

The models of reference need to be organized hierarchically in order to be mobilized according to criteria of importance. Therefore, each model of reference will be associated with a given emotion expressible in terms of quality and intensity. Our approach conceives emotions as nothing but the weights that our mind assigns to the models of reference. Again, we will have genetically inherited weights on the one hand and acquired weights on the other. As an example, let us consider the emotion of fear: we will have genetic fears such as the fear of snakes (or of insects) and fears acquired through negative direct experiences such as, for instance, the fear of driving a car after a car accident. A given configuration appears to our senses and triggers a certain number of models of reference. Emotions serve precisely the purpose of emphasizing some models over the others: the more intense the emotion the more our mind's attention and the resulting behaviour will be conditioned.

In consistency with our approach, also emotions follow the functional pattern of the models of reference. We will have positive emotions that activate states of wellbeing and negative emotions that trigger states of uneasiness. In a sense, the emotions are the internal equivalent of the sensations related to the nervous system's mechanisms of pleasure and pain. The source of emotions is always internal, whereas, of course, sensations may have both an internal source (backache) and an external one (burn). To simplify, but not too much, we might say that emotions are the "mind's sensations" and that they are fundamentally activated by our thoughts. Just as there exist different colors and sounds (even though the physical principle is the same) so there are emotions of various nature. Semantics fails to help us here, yet we may try to provide an initial classification of basic emotions by distinguishing them into negative and positive. A possible list of negative emotions might include the

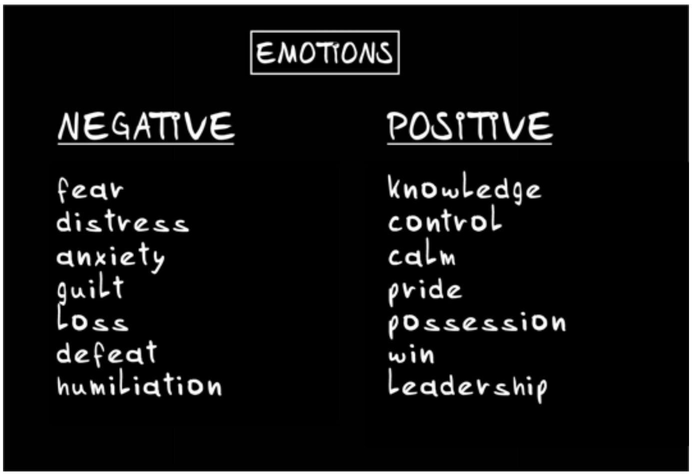

Fig. 9.3. Some basic emotions.

emotions of fear, anguish, anxiety, guilt, loss, defeat and humiliation. The equivalent positive list might comprise the emotions of knowledge, control, calmness, proud, possession, victory and authority.

9.4 Memory and the mental operating system

Only few linger over the concept of memory with the adequate attention. Yet it is one of the crucial passages of our history. We have come to see such concept as so natural that it is really hard to immediately appreciate its extraordinary power. Without memory, there would be no evolution, nor intelligence, nor life and there would be no Game. The birth of memory probably represents the biggest evolutionary leap in the history of the universe. The possibility to store an event within a system marked the birth of the living systems. And nearly everything in our brain is memory, the product of both our own experience and that of our ancestors. Hence, we expect there exists within our brain a module responsible for organizing and managing memory, namely a sort of mental operating system. This module performs the tasks of arranging our memories, administering both short- and long-term memory, of associating memories with emotions. In more general terms, its task is to coordinate all the models of reference. We envisage such module as basically neutral with respect to the execution of the various tasks and we believe that it is exclusively concerned with making all the other modules operate as efficiently as possible.

It is the short-term memory that enables our senses to transmit to our mind the data collected from the outside environment; in other words, our eyes are able to see thanks to the short-term memory. And it is the long-term memory that allows us to recognize a particular face or to perform a certain sequence of movements useful to our survival. It is thanks to the memory of our DNA that the models of reference are passed down from generation to generation and it is again memory that allows these models to be inscribed within our brain and thus to be used to live.

Memory implies the persistence of information. Therefore, the appearance of memory requires a far from trivial circuit. Notwithstanding what is stored (namely its meaning), in order to make information persistent, we need to use an adequate material allowing us to do so, namely, something to write it and something to read it. As far as writing is concerned, it is necessary to perform a copy operation. In our opinion, this is another concept that, so far, hasn't been delved into properly: there can be no memory without copying. Only later there will be the comparison, the allocation to classes, any possible transformation, but first of all a copy must be made. Hence, the copy operator is the primary operator for the birth of a living system.

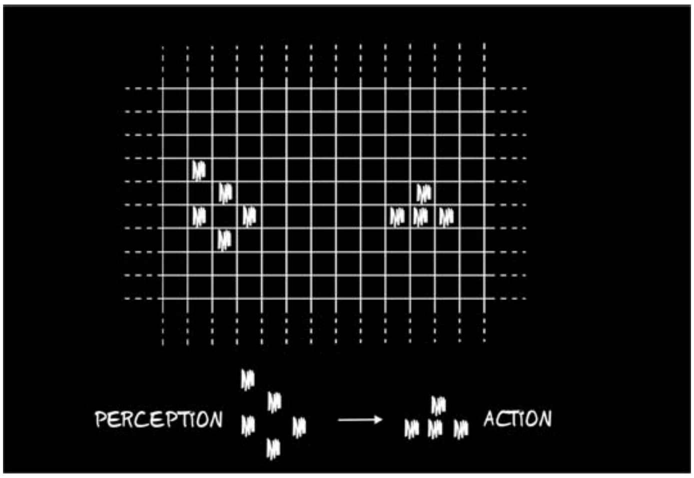

Fig. 9.4. The mental operating system matrix.

The fundamental task of the mental operating system is to organize all the information in a consistent manner. Functionally, from a figurative point of view, it might be useful to imagine it as a huge matrix. The data are written into the matrix by all our sense organs, both internal and external (perceptions). The emergence of specific configurations will determine the activation of the respective models of reference. Some configurations will cause the execution of final actions, other instead will trigger further sequences of models of reference (thoughts).

We believe that, besides the modules responsible for logical-analogical-realizational reasoning, the sensorial-emotional module and that of memory, within our mind there exist at least three other fundamental modules, i.e. the modules of knowledge, of learning and of language. In the previous chapters we have discussed the module of learning and that of knowledge in detail. As far as the module of language is con-

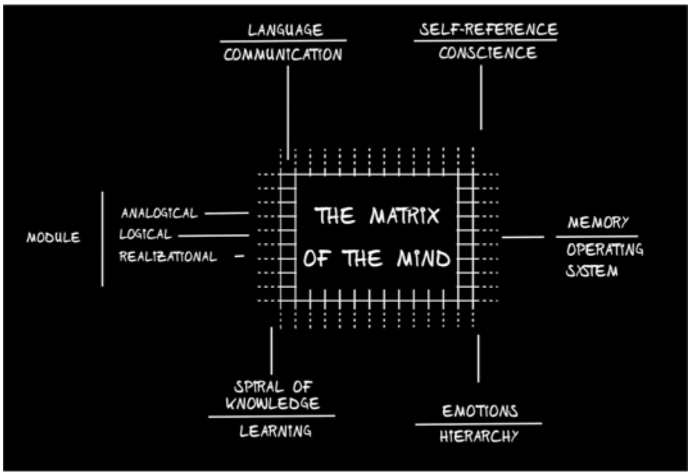

Fig. 9.5. The model of the operation of the mind.

cerned, we think that its development stemmed from the needs of communication among members of the same species and that it is present in most, if not all, the living species. It is likely that there exist other specialized modules and therefore that our model of mind will have to be adjusted in the future. However, we believe that this is already a valid starting point to come to understand (and thus reproduce) a considerable number of human mental processes.

Obviously, our model not only has computational repercussions in the field of artificial intelligence, but it also brings about therapeutic consequences in the sphere of psychoneurophysiology. The basic idea is that all the modules of our mind are closely connected with the functioning of our body. Now let us proceed to the analysis of the guidelines of this theoretical framework.

9.5 Biological changes induced by mental states

Those who investigate the relationships between, for instance, the mind and cancer do not maintain that the tumor disease is a direct representation of our emotions. Any illness is never the linear product of anything, let alone a complex, multifactorial disease characterized by a long incubation period such as cancer is. In fact, this is not the point: rather, it is important to note that the brain has bi-directional communication paths with the other general control systems and, also by means of the latter, with the organism as a whole. Mental activity and emotions circulate through these circuits, they become modulators and modifiers of biological states and therefore they can both function as facilitators of the action of environmental carcinogens or as obstacles to carcinogenesis. This is why many studies have focused on the search for evidence of the biological changes induced by mental states[81].

Throughout these years of work, we have been given the opportunity to observe how the empathy between the therapist and the patient may indeed contribute to accelerate the self-referential recovery[82]. The implementation of customized techniques designed to synchronize the large and small mind-body connections, rapidly leads to a form of adaptation and flexibility in which the system man restore itself. On a conceptual level, it doesn't seem odd that the mind may be effectively employed in the fight against cancer[83], just as with all, or nearly all, the other diseases. We know the links with the immune system, namely cancer's mortal enemy; we know that the mind may act as a modulator (enhancer or repressor) of the immune response; we sense that the state of the internal environment, i.e. the great psycho-neuro-endocrine-immune connection, is able to influence the microenvironment where a possible disease might begin and then develop. The techniques employed in the centers of psycho-oncology are many such as, for example, relaxation techniques, hypnosis, self-hypnosis, guided imagery and biofeedback. All these techniques, if customized, can be used also for other diseases. Low levels of stress resulting from the minimization of the problem (or denial) generally lead to a worse prognosis. By contrast, it seems that a better prognosis is achieved by the subjects with high levels of stress and thus capable of *coping*[84], a term that means “succeeding”, “effectively battling with”. By this, we define a person's capability of reacting, that is to say, the ability to mobilize one's resources in an extensive and goal-oriented manner. Nevertheless, beware that high levels of stress are not positive per se, since they must certainly be accompanied by high levels of “coping”. In essence, there is no point in despairing, rather it is vital to mobilize.

In accordance with many researchers, most notably Paul Watzlawick and Gregory Bateson, what would be most needed is not to treat but rather to teach in a “school” for pupils who have contracted some disease and whose system fails to recognize the way to proceed. New landmarks should be taught. This school takes the individual to a transformation. People who feel involved, inasmuch as they perceive to have control over their own condition, and who look at various situations as a demanding challenge, will probably respond to stressful events by increasing their interaction with such events: examining, monitoring and learning from themselves.

The shape of the ageing curve is not the same for everyone. Some persons completely avoid certain symptoms associated with old age, whereas others begin to suffer from such problems well before entering old age. Besides genetic and environmental factors, among the main culprits that contribute to these differences we may place our behaviours and, in particular, our training in relation to life choices, namely choices where will, emotions, renunciations, knowledge all play a role.

Basically, there exist three types of age according to which a person might be classified. Chronological age (i.e. the one provided by the calendar), biological age (i.e. that of the body in terms of the vital signs exhibited by cellular processes) and psychological age (i.e. how old one feels to be). Of the three, only the first is certain, nevertheless chronological age is not more reliable than the other two, quite the opposite. A fifty-year old may be just as healthy as he was at twenty-five, whereas another one may already have the body of a sixty-year old or even a seventy-year old. In order to actually ascertain one's own age, the second measure, i.e. biological age, must come into play: it tells us the extent to which time has left signs on our organs and tissues as compared to other people of the same chronological age. Nonetheless, time's action is not uniform; in reality, each cell, tissue and organ ages at its own rate, thereby making biological age much harder to determine than chronological age. The more time goes by, the more we become unique. Each one of us ages in our own peculiar way.

The third measure, i.e. psychological age, is even more flexible. Just as biological age, also psychological one is highly personal: there cannot be two persons with the same psychological age for two persons cannot possibly have undergone through the exact same experiences. Psychological age is something more than the saying "you are as old as you think you are": modifying one's own psychological age implies interacting with a vast array of personal and social factors. It is precisely the combination of a series of factors in our social and personal life that will enable us to achieve a prolonged longevity. A crucial element for the attainment of such goal is the ability to be flexible and to transform ourselves, to touch both the strings of joy and those of pain, to accept reversals of fortune as well as sudden enlightenments. It is of the utmost importance to understand that biological age is directly related to psychological age. A rich inner life full of achievements enhances the power of awareness to defeat ageing at its source. In contrast, the shifts of awareness in the direction of apathy, hopelessness and dissatisfaction push the body towards a rapid decline.

It is sad to see an elderly person who gives up the desire to live, and it is extremely difficult to show her what she is doing. By closely observing decay and the apathy marking an unwelcome old age, we can realize how the intelligence left unexploited during one's youth has come to "sicken" the will of the elderly. When life becomes meaningless, the energy that sustains the body seems to drain away like a run-down battery. If we watch even closer, we can demonstrate that this loss of vitality, curiosity and desire to live might be controlled and, in fact, it has nothing to do with the regular ageing process. Our body self-regenerates, it automatically replenishes itself with energy after moments of exhaustion. No matter how severe the stress was, once the response has been activated, the body regains its balance. This tendency to remain in equilibrium is absolutely essential to life, a key mechanism of survival.. Although all of us are confronted with moments of anguish, shock, sadness and disappointment, there are some persons who recover better than others. We must learn to respond creatively to change, preventing anxiety from spreading unleashed within our organism. We must refine the ability to integrate new elements into our lives. For some of us, the journey of life, though seemingly harsh, is linked to an elastic approach preserving from fragility. Adaptability, in its simplest definition, is the freedom from conditioned responses and the ability to formulate new ones. Remaining open to change, embracing the new, welcoming what we don't know are all choices that involve well-defined personal skills. When left to inertia, the mind tends to reinforce old habits thereby increasingly falling prey to conditionings.

9.6 Interactions between the emotional emodule and the three modules of reasoning

The logical, the analogical and the realizational modules are distinct modes of comprehension which we are usually aware of: they occupy a prevailing position in consciousness and reflection and, albeit with different modalities, they are able to ponder and to reason. However, as we have seen, they are accompanied by another system of, impulsive and powerful, often even "inconsistent", knowledge, namely the emotional module. The dichotomy between emotions and reasoning is similar to the popular distinction between heart and mind; when we know that something is "right", somehow we perceive it as a certain knowledge that is much deeper than rational thought. Mental scrutiny, in turn, refines and sometimes vetoes the inputs of emotions. Nevertheless, reasonings and emotions are semi-independent faculties: each reflects the operation of distinct, but interconnected brain circuits. The ratio between emotion and reasoning varies along a continuous gradient; the more intense the emotion the more dominant the emotional module and the more ineffective the others. In most cases these modules operate in great harmony with each other and, as different as they are, their modalities of knowledge complement each other to guide us in reality. These modules are perfectly coordinated; emotions are essential to reasoning just as the latter is essential to the former. However, when emotions intensify, the balance is reversed: the emotional module tries to get the upper hand, thereby overwhelming the other modules.

The most ancient roots of our emotional life are probably connected with the sense of olfaction, or more specifically, with the olfactory lobe[85], where the cells that receive and analyze smells reside. Later, from the olfactory lobe the ancient emotional centers began to evolve until they finally became sufficiently large to encircle the cephalic end of the brain stem, namely the limbic system[86]. The evolution of the limbic system brought about the enhancement of two faculties: learning and memory. The neocortex[87] is responsible for a considerable part of human high-level functions since it is the seat of thought; it contains the centers that integrate and comprehend what is perceived by the senses; furthermore, it supplements emotions with what we think of them (understanding) and enables us to feel emotions in relation to ideas, art, symbols and imagination. This new component of the brain allowed many new nuances to become part of the emotional life. Let us consider for instance affectivity. Limbic structures generate feelings of pleasure and desire, namely the emotions that fuel sexual passion. The larger the number of such connections, the broader the range of possible responses. The neocortex permits us to experience the subleties and the complexity of emotional life, such as the ability to have feelings about feelings. This gives the emotional centers the huge power to affect the operation of all the other areas of the brain, including the centers of thought.

The sensory experience of pain has a lot to do with the mindset. The worst attitude towards pain is to, either physically or mentally, polarize all the tension on pain itself in an attempt to dislodge it. The only result of such resistance is to increase both the physical pain and the psychological distress stemming from our behaviour. Inasmuch as emotions hinder or enhance our ability to think, to plan, to solve problems, to undergo training in view of a distant goal, all they do is to define the boundaries of our capacity to exploit our innate mental skills. Inasmuch as our actions are motivated by feelings of enthusiasm and pleasure, or even by an optimal degree of anxiety, we are driven towards accomplishing our projects. In this sense, emotional intelligence[88] is a fundamental skill that profoundly affects all the other, at times propelling their expression, at other times interfering with them. Perhaps there doesn't exist a more important psychological capacity than that of being able to resist impulses. In fact, it is the very foundation of any kind of emotional self-control, considering that all emotions, by their own nature, result in an impulse to act. What starts to emerge in the early phases of growth, over the years develops in a wide range of emotional and social skills. The ability to restrain impulses underlies a vast number of the efforts of the adult, from controlling one's eating regime to attaining a degree[89].

The capacity to subdue impulses to pursue an objective, regardless of whether it is to close a deal or solve an equation, emphasizes the role of emotional intelligence as a meta-ability that determines the degree to which the individuals are able to use the other mental abilities. Those persons who are capable of harnessing their emotions may exploit anticipatoy anxiety as a motivational tool to prepare themselves for the upcoming challenge and therefore to succeed better. As we know well, the relationship between anxiety and performance, including the intellectual performance, can be described by an inverted U-curve. The top point of the curve corresponds to the optimal relation between anxiety and performance, where the moderate level of nervousness acts as a propeller towards an excellent performance[90]. Too low a level of anxiety results in apathy or however an insufficient motivation to work hard; out-of-proportion anxiety translates into the sabotage of any attempt to succeed. Being in a good temper, as long as it lasts, enhances the ability to think flexibly, thereby leading to the attainment of higher levels of complexity and simplifying problem solving, regardless of whether we are dealing with intellectual or interpersonal issues. The benefits of a good laugh on the intellect are most evident when one has to solve a problem that requires a creative solution.

Even slight changes in mood can affect thought. When engaged in planning or decision making, good-humored individuals tend to perceive the situation positively, which leads them to be more outgoing and optimistic. This occurs because memory is a specific function for each state, and therefore when we study in a good mood we recall a larger number of positive events; if we weigh the pros and cons of a given action while we are feeling good, then memory will guide our judgment to a positive direction, thereby increasing the likelihood of opting for a slightly adventurous or risky course of action. Conversely, bad mood drives memory towards a negative direction, thereby increasing the likelihood that the individual will make an over-cautious decision dictated by fear. When left completely unbridled, emotions may hinder the intellect, but it is however possible to regain control over them; this is a crucial competence for it promotes the expression of all the other types of intelligence. The persons who are able to hope share some important characteristics, including the ability to self-motivate, the feeling of being endowed with the resources necessary to achieve their goals, the ability to self-reassure in times of trouble by leading themselves to believe that things will get better and an adequate flexibility to devise new ways to accomplish the set objectives or to change them should they become unattainable; finally the capacity to break a big problem into several smaller and manageable sub-targets. From the perspective of emotional intelligence, to hope means not to give in to a shattering anxiety, not to take defeatist attitudes and not to resign to depression in the face of burdensome challenges or failure.

To be optimistic means to entertain firm expectations that, despite the failures and frustrations, the events of life will turn for the better. From the standpoint of emotional intelligence, optimism is an attitude that prevents the individual from sinking into apathy or depression and from slipping into despair over difficult situations. Optimism turns out to be a considerable advantage in terms of how people explain to themselves their own successes and failures. Optimistic individuals ascribe failure to details that can be changed to ensure good results in future attempts, whereas pessimists take the blame on themselves, attributing failure to some intrinsic aspect or circumstance they are unable to change. These different lines of explanation have a profound impact on how people react to the various events of life. For instance, when confronted with disappointment, optimists tend to respond actively with a positive attitude full of hope, formulating a plan of action or seeking someone's support and advice; they see failure as something that can be remedied.

At the present time, perhaps we let ourselves experience emotional peaks because, at the end of the day, our time is limited and we tell ourselves: "let's live it all and try it all because we haven't much time left!". But let us imagine an eternity of our existence with our mind and emotions yoyoing up and down thereby depriving us of energy. How the individual emotionally reacts to a defeat is of the utmost importance for the ability to self-motivate to move forward. Mental attitude, be it positive or negative, may well depend on innate temperament; some persons, by their very nature, tend towards one or the other, nevertheless optimism and hope can be learnable tools. The belief of having control over one's life and of being able to accept challenges when they come one's way as well as cultivating a skill of any kind strengthen this feeling by amplifying the individual's willingness to take risks and to embark on increasingly demanding endeavours. We must immerse ourselves in what we call "flow". Flow is a state in which the individual is unconcerned about herself, i.e. the opposite of brooding over and worrying. Paradoxically, the individual who is in a state of flow exhibits a masterly control of what she is doing and her tresponses are perfectly synchronized with the changing demands of the circumstance. Meditation precisely educates you to enter the flow state. Although the individual in a state of flow delivers top-level performances, he is never preoccupied with doing well or not, she never lingers to think about success or failure: the sheer and simple pleasure of the act itself is enough to motivate him[91].

[74] *Are there any theoretical limits to the exhaustive reproducibility of the human mind?* The treatise "An investigation on the Laws of Thought" was written by a Nineteenth century English mathematician and it stands out as one of the most pivotal works in the history of logic and algebra. George Boole, namely the founder of the algebra named after him, was among the first to recognize the possibility of using algebraic language and tools to represent both our thoughts and logical relationships between them (for example, the famous Aristotelian syllogisms). From Boole to Alan Turing, from John McCarthy to Douglas Hofstadter, there has been the recurring thought that the potency of mathematical-logica symbolism to represent reality may indeed be the key to the ultimate, and most important, modelling effort, namely the modelling of human thought processes. Ultimately, thinking is computing. The advocates of the AI research program conceive creativity and emotions as high-level phenomena that arise in consequence of events that occur at lower levels. This implies that, even though such relevant lower level corresponds to some rigid and precise symbolism, perhaps yet to be discovered, the outcome at the higher level may easily be "astounding", "creative" and "emotional". By employing the language of our models of reference and the logic of perception-thought-action, it becomes clear that there is no restriction in principle to the reproducibility of emotional, artistic, creative behaviours. We may not know what models of reference give rise to Beethoven's Ninth (as well as how they are activated and, in turn, what they trigger), but we are reasonably sure that even this mental activity can be represented. It is therefore legitimate to ask ourselves whether there exists some domain that does not lend itself to the thorough modelling of reality, once mental processes have been excluded from the list of possible candidates. The only area that raises some doubt is the domain of sensations: pain, pleasure, tickle, the "qualitative" component of a sound, etc... Let us try to clarify this with an example. If I prick my finger, I feel pain and thus scream. The present state of our knowledge allows us to read a detailed, interesting and almost certainly accurate record describing this episode at a neurobiological level: some receptors on the skin of our finger alert the brain of such contact; as a result of this information, the order of screaming comes from the brain. This shouldn't frighten us inasmuch as it is a "process": it involves a "perception" by a sense and an "action" by the system, which are separated by a thought linking the perception to the respective action. Nevertheless, what seems to be missing in this picture is an important element: the pain I'm feeling. This is a very delicate

field and all of the options on the table are audacious: on the one hand, the operation of some "internal sense" may provide an explnation of pain relying on the usual logic ("functional" plane); on the other hand, there may exist a fundamental dimension of the real which is responsible for this phenomenon ("ontological" plane); finally, there might even be some combination of the two. The first way does not seem promising: when we speak of the pain we consciously (whatever that means) experience, no perception-thought-action model seems able to accurately get this phenomenon: by its very nature, the feeling is intrinsic and it doesn't seem to refer to any sense, or to any "before" and any "after". The perception-thought-action logic works for the neurobiological level which, however, has nothing to say about the emergence of sensation, thus it can neither explain nor identify with it. The second option is a good candidate to pave the way to new perspectives: in this light, sensation may be a particular "basic state" of reality and different from those states that serve as the building blocks of physical reality. Hence, there would subsist an inherent difference between the physiological mechanisms, as falling within the scope of biological explanation, and sensations, as independent on any sense; obviously, the laws of nature (whatever they be) in our universe ensure that specific sensations arise in correspondence of particular physical configurations: everyone experiences pain. Alternatively – engaging in even bolder speculations – the difference between physiology and sensation may not be due to different states of the same fundamental reality, but rather to the simultaneous presence of multiple, systematically related dimensions of the real. Or else, our entire reality may turn out to result from different states of sensation, thus also what appears as physical indeed exhibits qualitative features! What would be the implications of these scenarios on our computational efforts to model and reproduce reality? The most plausible answer seems to be the following: if – as we believe – the interpretation of the real rests on the models of reference and if –as a hypothesis – sensations (in experiential terms) appear to be beyond the reach of present understanding, then it is not yet possible to directly replicate them (as we reproduce sight, or self-consciousness). Nevertheless, what is of course possible is to replicate the mechanisms underlying sensations: in other words, if we construct a silicon robot endowed with the same perception-thought-action pattern that in humans result in pain, we expect the basic level of reality to "react" accordingly, thereby generating the sensation of pain in the robot as a result of the mechanism. This wouldn't allow us to directly create the shadows of our processes, but only to put the right silhouettes under the light of the lamp. We condider this problem to be the central problem from a cognitive standpoint: there is one question above all the others, what dimension does "will power" belong to? As there arises some specific perception that would deterministically cause an "inevitable" action, will power may be what apparently allows us to control and modulate the process. Is the exhaustive explanation to be found in the domain of the models of reference (for instance through inhibitor models of reference) or does will power fall into a distinct dimension? When we are able to answer this question in a precise manner, the Solution to the Game shall probably be within our reach.

[75] We may say that our research laboratoty has come into existence together with the notion of decision forecasting, predictions of both individual behaviours (such as purchasing decisions or the choice of partner) and aggregate behaviours (such as the trend of stock prices or a brand's ability to penetrate the marketplace). The rigorous test of behavioural predictions is the primary tool we use to validate a mental modelling theory: if it is identified as able to faily accurately predict a certain behaviour, then we take it into consideration, otherwise it is discarded. And it was precisely through this approach that, over the years, we have developed both our mental representation model and the related mathematics of the models of reference.

[76] *Motivational psychology and neuroeconomics.* A famous self-deprecating joke, which has also recently appeared on the *Economist*, celebrates economics as "the science that studies why its previous predictions did not work". In the recent past, "cognitive" economics (or "neuroeconomics") has fairly succesfully suggested a new approach to study and learn from the predictive failures of the traditional economic models. The basic idea is simple. Human beings are not perfect: for instance, it is a known fact that the vast majority of people make wrong inferences by incorrectly deriving new information from that already available to the agent. A sufficiently sound and "reliable" formal theory, i.e. logic, provides us with the tools to recognize and correct such errors by explaining how we should reason. Even though these principles were already known to Aristotle, no one can reasonably expect every single human being (even a professor of logic) never to incur in any reasoning "error" in real life. In fact, in everyday situations, two main classes of errors may distort our reasoning: on the one hand, there are the errors committed by the logical brain as it indiscriminately applies laws that are not sufficiently robust; on the other hand, the

analogical and realizational brains may interfere with the perfectly rational mental processes according to their own peculiar modalities. The former case is that of the so-called cognitive *biases*: our logical brain, probably for evolutionary reasons, does not always engage in a careful assessment of the available data, but rather it relies on computationally efficient and very effective shortcuts (i.e. "heuristics"). Therefore, approximate generalizations are applied to certain domains, thereby distorting the conclusions of reasoning. The latter case has been known to man, at least at the realizational level, for a very long time. In the year 1957 Vance Packard published a book that was bound to have a profound impact, namely "The Hidden Persuaders". In this study, Packard showed how many companies had been systematically using more or less sophisticated tactics to manipulate consumers' behaviour by taking advantage of the "weaknesses" that characterize the non-logical portions of our brain. There is no randomness in the world of marketing. The color of packaging, the music in supermarkets, the arrangement of products on the shelves: anything within the consumer's reach is purposely studied to influence purchasing decisions precisely by acting on those areas where rational behaviour has little, if any, effect. And more than this, television advertising industry has always relied heavily on motivational analyses to assess the reasons underlying commercial fiascos and successes of shows. At present, neurosciences, social sciences (motivational pychology *in primis*), cognitive sciences are both discovering and explaining that these behaviours are even more predictable than expected, thus they may be more easily influenced. Recent studies in neuroeconomics, as mentioned by Matteo Motterlini in his book "Emotional Economics", have essentially demonstrated for the field of economics what had been already known in logic for a long time: human beings are not (almost ever) utility maximizers, and this is the fundamental reason underlying the frequent failures of those predictive models that are solely based on the neoclassical decision theory (the axioms of rational choice theory as mathematically formulated by John von Neumann and Oskar Morgenstern in "The Theory of Games and Economic Behaviour"). It would be a bit like trying to predict the reasoning process of an ordinary man only by means of Goedel's logic!

[77] The path of mental growth is far from being risk free. For instance, in order to structurally enhance her own abilities, a person who is prevalently logical (or, according to our formalization, "vertical") has to become also analogical (or "horizontal"). By this way, the overall area will increase and, consequently, so

will her general cognitive abilities. The moment in which a logical person also acquires analogical traits (namely, when, in graphical terms, her psyche tends to come "dangerously" close to the shape of a circle) is marked by an intense mental instability, thus it should be handled with extreme care. The reasons underlying such instability haven't been fully assessed yet, hence, at present, we are only able to speculate on this matter. A partial explanation may lie in habit: if a person is accustomed to move in a "logical context", she will need some time to acclimatize to the unfamiliar "analogical context". Probably this is not the only explanation: it might be reasonable to hypothesize that the decision-making process of a "circular" mind is likely to be subject to a higher degree of controversy as compared to a mind that is markedly either "horizontal" or "vertical"; these continuous conflicts can undermine the confidence of the realizational mind, thereby making the mind as a whole emotionally weaker.

[78] It may be interesting to present the simplified version of the two-dimensional model (as referring to the logical mind and the analogical mind) which we use in our systems of psychological measurement: 8 spaces, each composed of 8 variables, for a total of 64 parameters. This model is a useful tool to evaluate both possible imbalances and the actual effectiveness of the interventions aimed at stabilization and enhancement.

1) **Syistem variables** (the space describes what may be referred to as a person's "mental hardware")
1.1 Amplitude
1.2 Synchronicity
1.3 Depth
1.4 Originality
1.5 Creativity
1.6 Practicality
1.7 Accuracy
1.8 Speed

2) **Summations of historical accumulation** (the space summarizes the results of the experiences undergone by the person in the various emotional and professional domains)
2.1 acceptance of Parents
2.2 Predictive achievements

2.3 Professional achievements
2.4 acceptance of Children
2.5 acceptance of Partner
2.6 Sexual achievements
2.7 Academic achievements
2.8 acceptance of Friends

3) **Mental attitudes** (the space describes what may be defind as the person's character)
3.1 Sensitivity
3.2 Responsibility
3.3 Will
3.4 Irony
3.5 Emulation
3.6 Education
3.7 Competition
3.8 Risk

4) **Perception of psychological time** (the space describes how the person perceives various temporal moments and the relative importance attached to each one, in other words it illustrates the temporal space the person lives in)
4.1 Remote Future
4.2 Tomorrow
4.3 Future
4.4 Recent Past
4.5 Remote Past
4.6 Yesterday
4.7 Past
4.8 Recent Future

5) **Perception of psychological space** (the space describes how the person perceives the different levels of her relating to others)
5.1 Nature
5.2 the Close Proximity (parents, children)
5.3 the Self
5.4 the Complementary (wife/husband)
5.5 the Transcendent

5.6 the Others (acquaintances)
5.7 the World
5.8 the Proximity (colleagues, friends)

6) **Areas of interest** (the space describes the attitudes and interests towards the main areas of motivation)
6.1 Health
6.2 Experiences
6.3 Culture
6.4 Money
6.5 Sociality
6.6 Sex
6.7 Power (Command)
6.8 Food

7) **Types of memory** (the space describes the person's characteristics with respect to her various memorization abilities)
7.1 Photographic memory
7.2 Short-term memory
7.3 Analytic memory
7.4 Parking memory
7.5 Logical orientation
7.6 Long-term memory
7.7 spatial orientation
7.8 Stack Memory

8) **Classes of learning** (the space describes the main learning modalities)
8.1 Direct Experience
8.2 Indirect Experience
8.3 Direct Knowledge
8.4 Fantastic Knowledge
8.5 Emotional Knowledge
8.6 Oneiric Knowledge
8.7 Abstract Knowledge
8.8 Simulated Knowledge

[79]*Stereotyped behaviours*. The term "stereotype was originally coined in the field of

typography to denote the duplication of a graphic element. Over time, the semantic sphere of this word has been widened. The so-called stereotyped behaviours are sequences of actions which are automatically performed by animals and human beings, very often without any real control over them. Examples of these phenomena in the animal world include dogs trying to chase their own tails and what in equestrian terms is referred to as "weaving", namely the vice of swaying from side to side in front of boxes, which is exhibited by some horses. In human beings, stereotypies are associated with disorders such as autism or schizophrenia, but also simple habits are considered stereotyped behaviours, in a broad sense, for instance the routine of following the same itinerary to get to any given destination without even thinking about it. The surprising thing is that, even when perceiving signals that would normally discourage the choice of that path (such as traffic jams, or long queues), if self-monitoring is not effective in blocking the stereotyped behaviour that has been triggered, the subjects nevertheless tend to take the same route, driven by the "force of habit". Some studies seem to demonstrate the partial advantage implied by these behaviours in metabolic terms: resorting to well-known situations enables the individual to lower her stress levels.

[80] The famous apologue of Buridan's ass, which died of starvation because he couldn't choose what grass field to eat from, was proposed by the philosopher Jean Buridan around the middle of the Fourteenth century and it was later elaborated by many other scholars, most notably Gottfried Leibniz in the "Essays of Theodicy".

[81] For instance, a study has examined a sample of psychiatric patients divided into two groups, depending on their degree of depression (higher or lower). The lymphocytes taken from the two groups were damaged with radiation. The goal of the research was to measure the lymphocytes'ability to recover from damage and the results showed that such ability was higher in the group with lower depression. Studies such as those of Ronald Glaser concerning the influence of stress on the immune system are now part of the history of psychoneurophysiology. When we speak of the power of our emotions and how our mind has the potential to actively help our body fight disease, we precisely refer to that set of correlations that have been highlighted by hundreds of studies over the recent decades. The role of depression in the onset of cancer is still controversial within the scientific community, yet a strong correlation between the two

pathologies has been effectively established and we expect that, in the coming years, it will be possible to clarify and highlight the temporal sequentiality between the two events (thus to discern between the true "cause" and "effect"). In the Eighties, building on the experience of the studies on lymphocytes, extensive researches on cancer patients have shown that tumors tend to spread with less difficulty in those individuals who are more emotionally repressed. Relying on these results and the type A and type B personality theory introduced by Meyer Friedman, Lydia Temoshok proposed a new category, namely type C personality. The person with type C personality exhibits a disregard for her own needs and bodily sensations resulting in the tendency to avoid cares from others, while rather taking cares of others. Moreover, the researcher emphasized a very interesting trait of the individuals with type C personality: they show a marked tendency to repression. Their reported reaction to the news of cancer resulted to be strongly correlated to the presence of a greater number of lymphocytes underlying the tumor. These results have led Temoshok to hypothesize that the suppression of anger (or other emotions) in the face of stressful situations may promote the development of malignant melanoma. In recent years, the concept of "personality types" has been subjected to numerous criticisms and adjustments and is still the center of much debate; nevertheless, we deem it highly probable that there may be a (certainly non-linear) correlation between "personality type" and the efficiency of the immune system (type C) and that of the cardiovascular system (type A).

[82] *The active ingredient of prof. Di Bella's method.* Luigi Di Bella, the famous deviser of a controversial cancer therapy, died in 2003 at the tender age of 91. Many patients claim that their cancers have been healed by the professor's therapy, whereas the neutral and controlled testing of such treatment protocol has given objectively unsatisfactory results. So who is right? From a "chemical" standpoint, the active ingredients underlying Di Bella's protocol are three hormones: somatostatin, melatonin and bromocriptine. Unless we hypothesize an unlikely (though not actually impossible) mass psychosis, it is a fact that, when the treatment was administered by Di Bella himself, it gave interesting results. Conversely, unless we (symmetrically) hypothesize that some evil scam had been masterminded by the minister of Health, the hormone cocktail designed by Di Bella proved ineffective when administered by others. And what if the active ingredient of Di Bella's method had been prof. Di Bella himself? All of Di Bell's patients were treated for free, those who knew him have always

emphasized his extraordinary human qualities and his very high degree of empathy. Could it have been such empathy to play a pivotal role in the healing process? Perhaps with the contribution of the hormone support that produces antidepressant, energizing and stabilizing effects. Notwithstanding all their good intentions, it is not hard to imagine the degree of empathy of the doctors who were responsible for the testing protocol. Loads of graphs, tables, "do you feel better?", "do you feel worse?", "now we do the blood tests"… in short, the most classical experimental patient and the situation was further aggravated by all the emotional stress stemming from the extensive media coverage of this event. But that was exactly the opposite of what occurred as one entered the study-laboratory of prof. Di Bella. The opinion of our research group is that this is one of the numerous examples in which the self-referential mechanism may have played a crucial role in the healing processes. If the information we have is reliable (on the one hand, the patients treated by prof. Di Bella did actually increase their chances of recovery and, on the other, the ministerial commission has not deliberately and aprioristically undermined the therapy), a possible explanation may lie in Di Bella's ability to stimulate the self-referential processes of patients, thereby fostering the "self-healing" process. The hormones affected mood and mood in turn affected the immune system: the empathy of the professor preparaed the ground, provided the energy and, most of all, the right "keys" to trigger the self-referential process.

[83] There is a huge literature on the relationship between mind and cancer. A useful starting point may be offered by the following twenty books, chosen among the most interesting works on the subject:
Biondi Massimo, *Mente, Cervello e Sistema Immunitario*
Bizzarri Mariano, *La Mente e il Cancro*
Borysenko Joan, *The Power of the Mind to Heal*
Bottaccioli Francesco, *Psiconeuroimmunologia*
Chopra Deepak, Ageless Body, Timeless Mind
Coda Rosamaria - Solano Luigi, *Relazioni Emozioni Salute*
Colligan Douglas - Loke Steven, The Healer Within
Hamer Ryke Geerd, *Il Capovolgimento Diagnostico*
Mambretti Giorgio, *Una Chiave per Capire, un Cervello per Guarire*
Marafante Daniela, *Cancro tra Mente e Corpo*
Meluzzi Alessandro - Duce Livia, *E se la Mente Guarisse il Cancro?*
Mussa Antonio - Torta Riccardo, *Psicooncologia*

Nesse Randolph - Williams George, Why We Get Sick
Pearsall Paul, *Super Immunity*
Pert Candance, *Molecules of Emotion*
Renard Leon, *Le Cancer Apprivoisé*
Rossi Ernest, *The Psychobiology of Mind-Body Healing*
Sapolsky Robert, *Why Zebras Don't Get Ulcers*
Simonton Caro - Matthews Stephanie - Creight James, *Getting well Again*
Smith Linda, *Of Mind and Body*

[84] *Coping*. The term coping refers to the set of cognitive and behavioural efforts and strategies an individual resorts to in order to manage, reduce, mitigate, control and tolerate both the internal and the external demands placed by any event. Borrowing from the third principle of dynamics, we may say that to every action or event of our daily life there corresponds a reaction that is produced by our body to allow us to deal with it as efficiently and advantageously as possible. *Coping* is a resource of the utmost importance and, over the recent years, it has been increasingly taken into consideration as an effective tool in the fight against cancer and leukemia. In fact, it appears that high levels of stress do not necessarily constitute a negative factor as shown by several studies highlighting that a better prognosis is associated with an elevated level of stress (which signals the individual's *coping* ability), rather than lower levels of stress which are related to the individual's attempt to minimize the situation.

[85] *The olfactory lobe*. The olfactory lobe, or rhynencephalon, is the portion of the brain which is responsible for the recognition of olfactory stimuli. Its structure is one of the most ancient and, due to its multiple functionalities, it has been favoured by natural selection. The olfactory nerve endings penetrate into the deeper layers of our brain, connecting with the limbic system, the hippocampus and the nucleus of the thalamus, namely the regions which are responsible for processing emotions and memories. Therefore, there is no casualness in the common experience of being "overwhelmed" by a certain odor that in the mind triggers a flood of images of places and people with such an intensity which is unknown to the other senses. Olfaction also concerns the endocrine system, the hypophysis and the pituitary gland and it affects the hormonal balance involved in eroticism and sex; the importance of smell in the sphere of love is emphasized by a number of researches which have revealed that in the early stages of falling in love any unpleasant smell of either partner is perceived as attenuated

or even not perceived at all. Love is blind and, if necessary, it is "anosmic" too.

[86] *The limbic system*. When we speak of "limbic system" we are not referring to an actual organic structure, but rather to a functional concept. The organic components of this system are the following: the amygdala, the hippocampus, the cingulate cortex, the fornix, the septum and the mammillary bodies. In the year 1937, it was James Papez to suggest that this system was responsible for the control of emotions. The limbic system is very ancient in evolutionary terms. Several studies of comparative anatomy have shown that, though there are differences with respect to its size and extent, its development and organization are remarkably similar across different species of mammals. Furthermore, the areas of the limbic system also contribute to two key functions of animals, namely the preservation of the individual and the preservation of the species. In the former case, the system regulates emotional reactions, fear, the *fight or flight* phenomena. As far as the preservation of the species is concerned, the limbic system controls sexual behaviour. Lesions of some areas of the limbic system may result in serious consequences for our health, including impotence, hypersexuality and even deviations in sexual behaviour.

[87] *Neocortex*. The cerebral hemispheres are covered by a layer of tissue called the "cerebral cortex"; in humans , about 90% of such cortex is composed of neocortex. Structurally, the neocortex is made up of six distinct layers which are distinguished depending on the type of cells. Functionally, this large portion of our brain is responsible for numerous tasks: it is where many sensory signals arrive at and where motor commands are sent from; it also hosts Broca's area, which is responsible for language, as well as several centers that are associated with emotional processing. Moreover, this is the region of our brain which differs the most from the other species. For this and other reasons, neocortex is deemed to play a fundamental role in the implementation of the phenomenon of consciousness.

[88] *Emotional intelligence*. "When I find myself in that situation, I feel beside myself and I lose my mind… I know it's wrong, but what can I do? This is me".Thanks to the studies of authors such as Jerome Kagan, it is now a fairly established fact that every individual iat birth s endowed with a particular disposition and temperament. Notwithstanding the undeniable role played by genes in shaping the structures which are responsible for the emotions, Daniel

Goleman argued that such structures are however characterized by an extremely plastic nature, hence it is possible, if not essential, to mold them through education. His work "Emotional Intelligence" has become a best seller not only among psychologists, but also for the public at large. Through this book, the author invited us to explore a world that is far too often overlooked in our times, namely the sphere of emotions and feelings. Goleman begins with a thorough exposition of the latest researches in neurophysiology, then he moves to the discussion of the import of emotionality in our society according to which emotions should be relegated to a secondary, and often inconvenient, role with respect to logic and reason. Emotions instead provide crucial guidance for handling interpersonal relationships in the most diverse situations and this is why it is vital for us to become sufficiently wise so that, to paraphrase Aristotle, we can discern when to get angry (and when to be pleased), with whom and for how long. The emotional intelligence Goleman refers to rests on the cultivation of that sensitivity which provides us with the tools to evaluate the adequacy of our own, as well as others', opinions with respect to the context.

[89] Several experimental studies performed on children in school age have shown that some already master this ability, as they can interpret the social situation and recognize the circumstances when postponing an action is the most convenient option; they are able to divert their attention from the temptation and, despite the momentary distraction, they also manage not to abandon the final goal. Although some claim that IQ is immutable and thus that it represents an insurmountable limit to the potential of human being, many tests highlight the possibility to learn certain abilities that belongs to the emotioanal sphere, such as the ability to control impulses and to adequately interpret a social situation. Almost a thousand years have elapsed since Pierre Abélard wrote: "evil thoughts, and even pleasure, are not of themselves sinful, but only the consent given to them". The ability to manage one's own urges is a lesson everyone should learn and the sooner the better.

[90] What is the relationship between anxiety and performance? "performance anxiety" is a condition which has sometimes been experienced by all of us in a variety of circumstances, both public and private, and such state is not likely to be beneficial to our purposes. However, the relationship between these two variables does not always result in an unfavourable outcome. When the relationship between anxiety and performance is translated into a Cartesian graph, it will

appear as a sort of "inverted U". The total absence of anxiety will be associated with average-low performance inasmuch as anxiety is not necessarily an emotional obstacle, but rather it operates as a real psychological and physiological incentive. Anxiety triggers the stress response that enhances our resources by making us more active, thereby increasing our resistance to distractions that may divert us from our task and therefore our overall efficiency. Obviously, an excess of anxiety leads to overabundant responses which then turn into obstacles: this explains why, once the peak of the curve has been reached (and such value varies from individual to individual), any further increase in the level of anxiety results in a deterioration of performance. Emotional intelligence may be extremely helpful in handling our own resources by adequatly managing our own anxiety.

[91] *Will to power, Nietzsche's overman.* Among the most controversial and fascinating "characters" ever appeared in the history of philosophy, Friedrich Nietzsche' s overman certainly occupies a special place. Beyond all the bizarre and disorted interpretations given to this concept, the overman is a fundamental theoretical piece in Nietzsche's analysis of humanity, as it is excellently synthetized in the "Zarathustra": "man is something that shall be overcome... man is a rope, tied between beast and overman". And it is in this context that Nietzsche's famous theme of the death of God is to be understood: various reasons have led man to lose his faith in absolute and transcendent values such as God, Truth, Good, Salvation, so all he is left with is a completely meaningless existence; if the world of man mirrors the world of God and the latter falls apart, then lthe former remains shapeless. As far as men are concerned, this marks the beginning of a period of apparent discomfort which actually conceals huge possibilities: in fact, men have been finally liberated from the shackles of a partial and ficticious vision of life and they can take on the creation of a whole new set of goals and values, namely a world where existence is accepted and embraced in its entirety, including the moments of deepest pain and of most instinctive passion. The overman is a man who is able to live by welcoming life, as a "brave pessimist" (like Dionysus), who, in the tragic disorder of being, can assert himself as the only source of sense, values, meanings, who knows how to enhance his body, thereby upgrading his soul. The overman is happy and full of energy: in the words of Nietzsche in "The Dawn", "the first effect of happiness is the feeling of power which wants to express itself, either to us ourselves, or to other men, or to ideas or imaginary beings". This will to power is the ultimate essence of

the phenomenon of life: it does not depend on the "I" or any substance (according to Nietzsche, the "I" is a grammatical fiction), but rather on life itself which is subject to constant evolution. The will to power, which finds its expression in the overman, first and foremost, is a reminder of the immense array of possibilities offered by life in all of its facets, with the awareness of the necessity of a monumental change to enable humanity to reach this age: Nietzsche conceived the overcoming of "traditional" society not only as necessary, but also as fully justified inasmuch as it builds on nothing more than a collection of ghosts, the crystallization of all the deceptions and excuses that have been devised by weak men.

10. The Mathematics of the Models of Reference

In this chapter we will introduce the foundations of the mathematics we have developed to computationally use the concept of models of reference. This is a fairly technical chapter and, for some time, we had been hesitant about including it in the book. Then, the opinions of many researchers convinced us to do so. We hope it will be useful. Our approach is an attempt of computational universalization applicable to the behaviour of any living system, therefore such approach exhibits, so to speak, "fractal" characteristics: we believe that the models of reference can serve as a computationally effective base at any level of reality. Wherever there is information processing, from the single cell to man, through all the intermediate levels, the mathematics of the models of reference applies, just as the morphology of fractals in which the pattern persists at any dimensional level[92].

As it is often the case with building something from the ground, the philosophical component plays a central role and strongly influences the path. Consistently with our organic view that inextricably links the physical world to the information world, we will start from the same four axioms used in our description of the physical universe and which are probably still very far from being provable. Many might judge this option as a formal weakness. It is true, we also hold the same opinion. Nevertheless, we need this mathematics to move forward; in any case it has proven useful to start to tackle the analogical and realizational components of our mind (which we wouldn't otherwise been able to deal with at a computational level), to treat patients and to pursue the development of artificial intelligences. Our bet is that the model of universe we have formulated may indeed be very close to the correct one. Our hope is that, regardless of the degree of truth of the model, the resulting tools will however be useful to get closer to the Solution to the Game.

First let us give some definitions. We define *space* as a set of discrete and contiguous cells. By *states* we denote the set of discrete values that a cell can assume. *Time* is the set of discrete and successive moments of existence of space. By *rules* we designate the set of laws governing the change of state undergone by the cells over time. Therefore, *universe* is defined as the set of space, states, time and rules.

We define *system* as any aggregation of contiguous cells within space. By *internal world* of a system we designate the aggregate of cells belonging to the system itself while the *external world* is the aggregate of cells that are not a part of the system. By *perception* we denote a modification in the internal world which is caused by a modification in the external world. We define *action* as a modification in the external world which is caused by a modification in the internal world. We define *thought* as a modification in the internal world which is caused by a modification in the internal world. We define *event* as a modification in the external world which is caused by a modification in the external world[93].

By *model of reference* of a system we denote a temporally ordered sequence of "perception - one or more thoughts – action".

Let us begin by considering a very simple universe composed of square-shaped cells that are adjacent to the other cells on two opposite sides. Thus, we will obtain a spatially one-dimensional universe, i.e. the equivalent of the straight line of classical geometry (or more precisely, of the segment, inasmuch

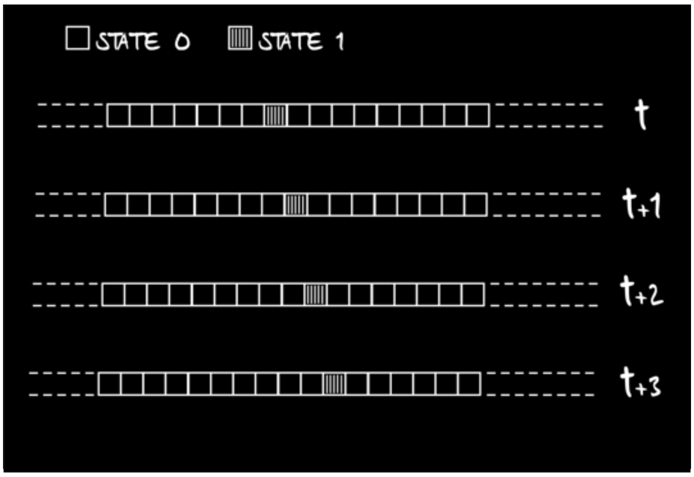

Fig. 10.1. Simple one-dimensional universe.

as we do not admit the concept of infinity. Let us assume the existence of two states (0 and 1) and let us assume the existence of one rule determining that, at each subsequent time, the cells "inherit" the state of the adjacent cell on their right side (by the term "right side" we refer, in an utterly arbitrary manner, to any type of purely descriptive spatial orientation that is directly derived from the morphology of our cells[94]). It is interesting to note that, from the standpoint of an external observer, the state-1 cells will appear as moving in a certain direction.

Now, let us consider, again in a totally arbitrary manner, a system consisting of two cells located in any one point of our one-dimensional universe. Until the cell that is external to the system, and adjacent to the cell situated at the right end, does not find itself in state 1, we will consider our system to be in quiet mode, namely its cells will not exhibit any kind of change of state. At this point, let assume the existence of an "event" (always with respect to our system) occurring within our un-

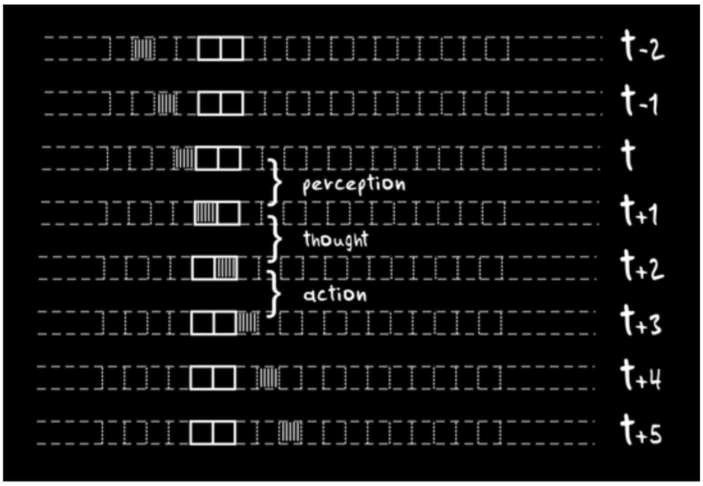

Fig. 10.2. The simplest model of reference.

iverse, for instance, the progressive "approach" of a state-1 cell. When, at some time t, the immediately adjacent cell takes the state 1, at time t+1, there will appear a "perception", at time t+2, there will rise a "thought" and, at time t+3 an "action". At time t+4, our system will return to quiet state until the emergence of the next perception[95].

We have just examined what might be regarded as the simplest "model of reference" possible: perception of a state 1 on the right side, internal transition of the state 1 between the two cells of the system (a "copy"!), action with respect to the external world which determines the change of state of the immediately adjacent cell on the the left side. This "semantic animism" should not be misinterpreted, obviously, its main purpose is that of facilitating understanding, nevertheleses, a scrupulous analysis will make you realize that it is fairly precise. We believe that what may be seen as an ordinary physical phenomenon, which occurs within an elementary "virtual" one-dimensional universe, is totally identical to any other, far more complex phenomena occurring instead in more realistic universes. From the perspective of the system under consideration, this hypothetically meaningless physical phenomenon is, to all intents and purposes, a model of reference, whether it concerns itself or other systems (therefore, assuming it is perceived by means of "senses").

Next, let us suppose we consider a one-dimensional universe composed of three states (0, 1 e 2) and two rules determining that, at each subsequent time, the cells "inherit" the state of the adjacent cell on their right side if the cell is in state 1, whereas they "inherit" the state of the adjacent cell on their left side if the the cell is in state 2. Again from the standpoint of an external observer, the state-1 cells will appear as "moving" to the right, whereas the state-2 cells will appear as "moving" to the left. As we shall see, this situation gives rise to a possible ambiguity that requires the introduction of a new rule or a new state (resulting in the redefinition of the two previous rules). If the states of two cells that may potentially "collide" converge by an even distance, then, as it might be uncomplicatedly verified, no problem occurs. Whereas, if they converge by an odd distance, at the last step of the approach we will have a situation where one cell of our unverse will not "know" whether to take state 1 or state 2 (inasmuch as it will have a state-1 cell on its right and a state-2 cell on its left).

This conflict of paramount importance may be solved in two alternative ways: either with the introduction of any one possible "ambiguity resolution rule" according to which the two states, for instance, "cancel each other out" (with consequent loss of information), or by increasing the number of possible states within our universe, thereby, for example, allowing the cell to take state 3 (hence, with no loss of information). In our universe, the process of ambiguity resolution would take place within what we call "potential time" according to adequate algorithms reasonably aimed at avoiding qualitative distortions.

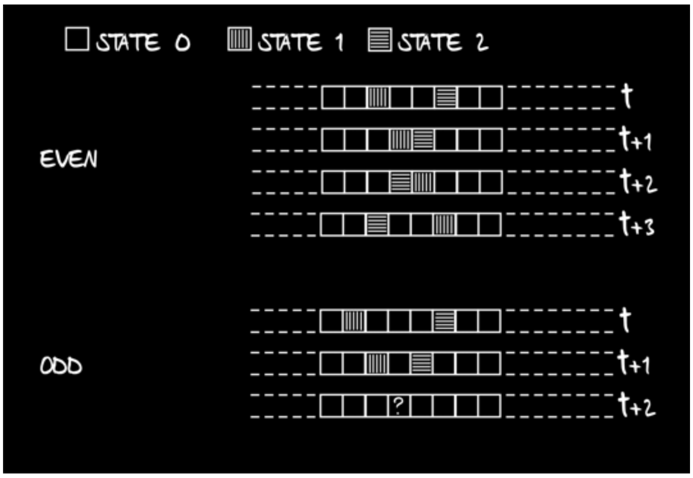

Fig. 10.3. A potential conflict.

The utmost attention should be devoted to the solution that includes an increase in the number of states. If we interpret the additional state 3 merely as a new possible state, then the main result is that there is no loss of information (which is already a good thing), but if we consider it also as the "sum" of 1 and 2, for instance, by expressing it as 12, then there may emerge "memory"! In fact, the cell not only inherits the states of the two adjacent cells, but, by suitably modifying the rules according to time, it will also be able to take different states. As we increase the number of states and rules, we enter the difficult part as far as the preservation of the perfect symmetry between the physical and information worlds is concerned. And it is precisely the emergence of memory that neatly highlights the most crucial problem: is the single elementary cell of our physical universe (just to make things clear, a cell of a size equal or lower than 10^{-35} mt) endowed with "memory"? Or does memory emerge only at a higher dimensional level as the result of the underlying implementation of the states and rules in function of time? For expositive convenience, we will henceforth

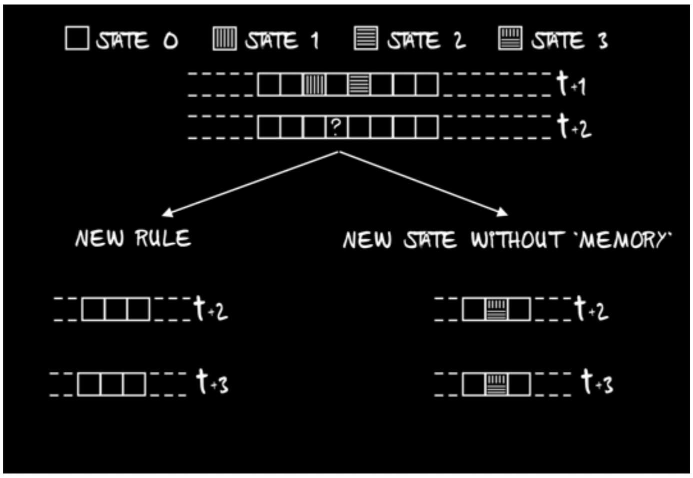

Fig. 10.4. New rule vs new state.

assume that the elementary cell does possess memory and we will "ignore" the fact that motion is only apparent. The first assumption will imply that, in the worst scenario, we have placed ourselves on a dimensional level higher than the ultimate one. Conversely, the second one is an inoffensive assumption forasmuch as any form of apparent motion within our universe can be easily be accounted for in terms of a change of states.

So let us return to our one-dimensional universe where each cell is able to move in two directions (dx =1, sx=2) or to remain steady (0). Let us introduce memory by increasing the number of the possible states each cell may take. Consistently with our last two assumptions, we will express such states as "temporal sequences of motion". For example, state 11 will result in two consecutive movements to the right, state 21 will cause a motion to the left and one to the right, state 20 will produce a motion to the left and no movement in the next instant. It is easy to ascertain that this universe has 9 (3^2) possi-

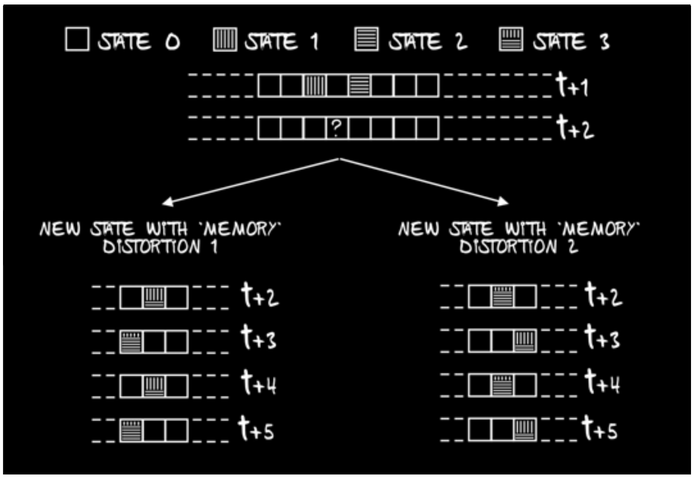

Fig. 10.5. New state with the rise of "memory".

ble states or, from an equivalent viewpoint, we may say that it has 3 states and a level-1 memory.

Having a level-1 memory in a universe of this kind is far less of a challenging logical leap than it might perhaps appear at first glance; in fact, if we admit the existence of a potential time, then it is sufficient that such potential time has some "knowledge" of the initial state of the cell: for example, assuming a state of a cell to be equal to 21, if the "actually observable" value corresponds to 2, then the following one can only be equal to 1. Nevertheless, at this point, we believe that the computationally more efficient and elegant option is that of increasing the number of states in order to directly embed the concept of "relative temporal position" into the state. The addition of a state indicating "the last state taken" allows to directly deal with temporal sequences longer than two moments. All this considered, it is fairly straightforward to verify that our universe is equipped with 18 (9x2) possible states. In general, the formula that enables us to express the need for

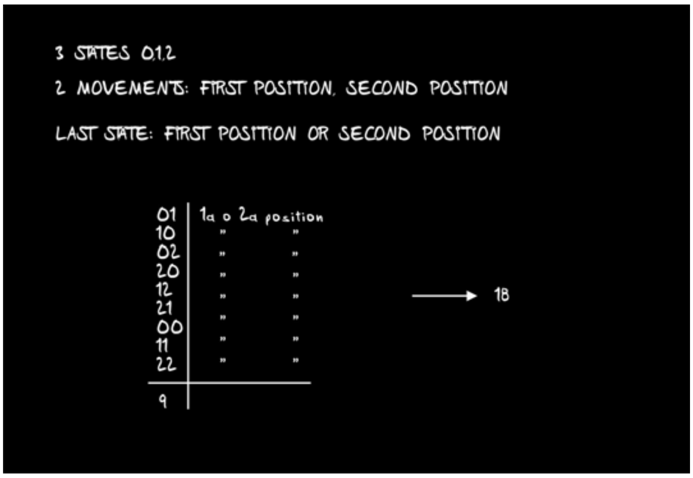

Fig. 10.6. Need for basic information.

basic information within our universes is the following:

$$\text{necessità informazione base} = \text{stati}^{\text{numero momenti}} \times \text{numero momenti}$$

This last type of state can be safely regarded also as a new "dimension" of the states, in other words, we will have a "two-dimensional state vector" formed by the state itself and by the relative time counter. This opens up a consideration of the utmost interest to the fans of the genre. The relative time counter needs to emerge only after some form of "qualitative exchange" between cells. If the rules did not provide for any kind of exchange and were exclusively concerned with the resolution of possible conflicts, then it would be sufficient to take into consideration absolute time (which is universal and identical for all cells). Let us examine why. First of all, let us assume that the rules specify the sequence of states to repeat indefinitely, i.e. once the last value is reached, the sequence starts over from the beginning (just for the sake of clarity, a state 11 will cause a continuous "moving to the right"). Notwithstanding the possible number of states that the cells are allowed to take, in our universe it will always be possible to know what state will be taken by each cell at the next time instant as long as, like we said, we know T, i.e. the absolute time of the universe, namely the number of instants that have elapsed since the origin of the universe. If we enter the constraint that all cells have uniform states and that they were all "born" at the same time, then it may be sufficient to know the value of an elementary absolute counter, whose maximum value will equal the number of states of the cells. We would be facing an outstanding computational efficiency[96]!

Remaining within the domain of our one-dimensional universe, now let us consider the behaviour of a cell in a state equal to 1121102. Hence, we will implicitly assume a universe characterized by at least 3^7 states and, specifically, our cell will move to the right by two squares, to the left by one square, to the right by two squares, remain steady, to the left by one square, and then again to the right by two squares, etc... Every seven time instants our cell would "move" to the right by two squares overall and our relative time counter would take on values from 1 to 7 and then again from 1 etc... If it were the only "active" cell in our universe (that is to say if it were the only one to have information content) no problems would arise, but if there were, at some distance to its "left", another cell of state 1222201, then, sooner or later, the two cells would "collide". Indeed, for the sake of accuracy, they would collide at a clearly identifiable time t which is a function of the distance between the two cells and, at this point, the state of our universe will depend on the rules adopted. Assuming a sort of "sum" of the information, we will obtain a so-called truth-table that will determine the outcome of the "encounter" between 1121102 and 1222201.

At this point, we are presented a range of interesting possibilities. The first one is that the information capacity of the single cell allows to combine the information of both cells. We will therefore have a cell that can be in 3^{14} states (our universe must be able to contemplate that) resulting from the actual union of the states of the two cells, such "thorough union of information" can be achieved in several ways: first the information of the right cell, then the information of the left cell, or vice versa, or, alternatively, first a state of one cell, then that of the other, etc... the number of possible combinations is really large. Nevertheless, it is reasonable to expect that, at a certain point, the cell my be unable to express any one type of state at a certain dimensional level and thus that, somehow, there would occur a loss of "historical memory". If we assume that 7 is the maximum dimensional level of the states of the cells in our dimensional universe, then the "sum" of the two cells will generate a new state belonging to dimension 7. Also in this case, the possible combinations are truly numerous: from the "overall exclusion" where there always prevails the information of the right cell, or where once there prevails that of right cell and once that of the left cell; to the "individual exclusion" where, as the relative position within the state progresses, the winner is, alternatively, once the right and once the left cell; to one of the two previous options complemented by some random or seemingly random component; up to an algebraically proper sum where the state of the cells can be seen as a "base-3 number" (with all the standard rules of the algebraic sum). It is interesting to note that the various cases will have their manifestation in the physical world and in the world of information, depending on the chosen rules: the "randomized individual exclusion" case resembles the behaviour of DNA, the case of the "base-n number" brings to mind the information processing within computers, while the "thorough union of information" case comes close to the behaviour of atoms, etc... Attention should be drawn to the fact that if the rules provided for some form of aggregation of several cells, then the information loss problem could be solved. For instance, let us suppose that the cell remains "single" up to the maximum

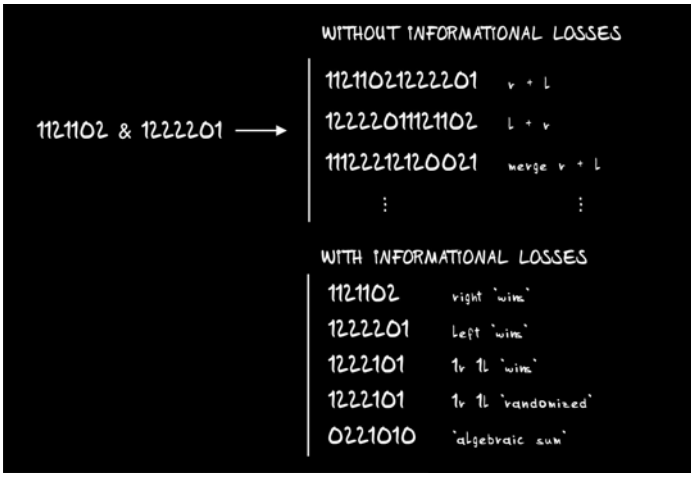

Fig. 10.7. "Sum" of two cells without and with loss of information.

value expressible by its dimensional base, and that, as soon as such threshold is exceeded, there results some form of aggregation among several cells. Essentially, it is what happens at the atomic level: when the space in the last available electrons' orbit is exhausted, the atom "expands" thereby occupying a new orbit. It must be borne in mind that, according to our approach, the perfect symmetry between the physical world and the realm of information subsists at levels far lower than the atomic level, nonetheless, we also expect such tendential symmetry to operate at higher levels as well.

Let us now analyze the case of a cell equipped with a state that guarantees a sort of "local stability", for example 1210212. It is not difficult to show that the cell will "live" within only two possible squares until some other incoming cell "interferes". Then, let us suppose there is another cell of state 1112111 and suitably located to the left of our first cell.When the two cells collide, depending on the rules governing our universe, we might observe a highly articulated set of behaviours. It is fairly uncomplicated to construct the rules so that, in function of the distance between the two cells, at least two cases might be envisaged: in the former case, the incoming cell continues its motion to the right at varying speed, while in the latter it "changes direction" and retraces its steps. We have thus reached a crucial point of our journey: if we consider the two squares of the initial cell as a system, then we will have a situation in which the output final state (action) is different from the input initial state (perception). Therefore, the information content of our universe has been modified by the intervention of our system. In order to describe what occurs, we are once again resorting to a sort of semantic animism, however, we believe this may be justified by the paramount importance of such a logical step: regardless of the interpretation we adopt, our universe includes a locally stable area that, on the basis of the existing rules, determines the change of physical states external to the system. The example is very precise and, we believe, rigorous. What we perceive as locally stable might as well be "moving" towards a certain direction (for instance, if the state were 1212212, we would have a "slow" motion to the left) without compromising the concept of system. Quite simply, the system will occupy different cells in function of time. In other words, when we "fixate attention" on a specific space at a given time, and we "identify" it in a certain manner relying on those we interpret as its properties, that system can move while still remaining "that system".

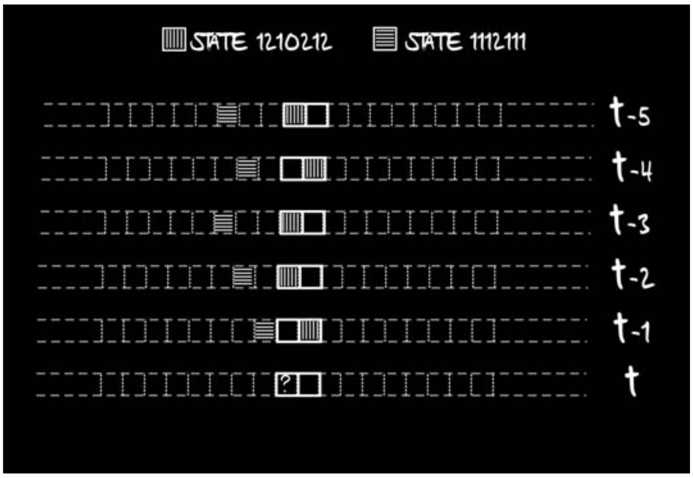

Fig. 10.8. System with locally stable properties and interaction with the "external" world.

To conclude our overview of the structural aspect, we believe that a thought-provoking way to examine the dynamics of our universe is to look at it as a flow of information that symmetrically corresponds to modifications in the physical state, which in turn might be perceived as motion in different directions. If we draw any boundary within our universe, thereby leading to the appearance of a system and thus of the concepts of external and internal, the information that "goes beyond the border" is modified or, symmetrically, the physical state undergoes a change, which in turn may be perceived as a variation of "motion". From the perspective of the system in question, we will have a certain information as input, a certain internal processing, and a certain information as output; or, alternatively, in line with our fundamental definitions, we will have a certain perception, certain thoughts, and a certain action; from the standpoint of apparent motion, such sequence corresponds to a given inertia motion vector, a "clash" and a specific modified motion vector.

It is our conviction that the approach of observing the phenomenon from the viewpoint of the system is extremely useful for computational purposes: the emergence of a particular configuration will trigger a certain internal sequence, which in turn will lead to a specific modification in the external world. At last, we have come to the vicinity of the ultimate essence of the concept of model of reference or, again for the sake of accuracy, of what we call model of reference. We hope that at this point in the discussion, you are comfortable enough with the fact that our concept of model of reference applies to any "physical or logical universe" we might think of: it is sufficient to draw the first boundary (i.e. the first arbitrary aggregation of contiguous cells) and that somehow the system "exchanges" information with the outside (or, depending on the conception we want to adopt, that it changes a state or deviates a motion). All these examples are inscribed in the context of a simple one-dimensional universe, but, obviously, if we move to higher dimensional levels, the same concepts are equally valid. From a theoretical point of view, there is no limit to the number of dimensions that might be taken into account, yet, after the third dimension, it would only be an effortful task to give an effective graphical representation and therefore to preserve a certain correspondence with what we commonly perceive as physical reality.

Now, we apply our approach to an example which is fairly simple, but, as we shall see, which will provide us with some interesting implications. Let us consider the model of reference "sum". At first glance, it might seem a rather primitive concept, as it indeed is, yet the steps leading to its univocal definition are far from straightforward. As usual, it might be helpful to try to grasp the essence of the problem. Try not to be dazzled by the upcoming example, it is deliberately "primitive" [97] but we believe it accurately describes what really happened throughout the history of human evolution.

We are the keepers of the camels belonging to our tribe, which is happily encamped in a beautiful oasis somewhere in the middle of the desert. Our task, besides taking care of them, is also to control them. How can we be sure that our neighbours, who are notorious slackers as well as thieves, haven't stolen one of our beloved camels from us during the night? Our father, from whom we learnt the trade, taught us to use a burnt-tipped wooden stick to trace a vertical line for each camel on a special flat stone. We add a line on the stone for every newborn camel and we erase one line with a wet cloth when one camel, unfortunately, dies. Every morning, each line we trace corresponds to a camel and thus we are able to unmistakenly watch them[98]. Here is a foolproof system!

In this case, our model of reference "sum" is basically synonymous with "aggregation" and it may be symbolcally represented in a two-state, one-dimensional universe as a system that "perceives" sequences of 1s separated by a 0 as input and that "provokes" as output a continuous sequence of 1s equal to the sum of the 1s contained in the various series. It must be stressed that, as far as the mathematics of the models of reference is concerned, how this occurs (namely, by means of what "thoughts) is irrelevant, what matters is that the outcome of the process is precisely what we have characterized as "sum". Therefore, the model is defined by what it does, not by how it does it. Here is a cardinal concept: the how is a function of the rules governing our universe, whereas the what is exclusively a function of the states. Hence, a model of reference can be conceived as an arbitrary label that is assigned to a specific sequence of changes of state. For example, if we consider a very complex system such as that composed of a person who is driving a car stopped at a red light, we may define as the model of reference "correct behaviour number 8826" the model of reference that provides for the traversing of the crossing as the green light flashes (perception: colour of the light, action: traversing of the crossing). We take no interest in how this happens, what concerns us is that it can indeed occur.

Let us return to our beloved camels. Our tribe is becoming more and more powerful and the number of camels is significantly increased over the last weeks, to such an extent that we are no longer able to trace the lines on our special stone in an orderly manner. We go through a few sleepness night, worried about the situation, but then a genius idea strikes us (truly genius in evolutionary terms): when the number of camels is equal to the number of fingers in two hands, we will not use the corresponding number of “straight” lines, but we will rather trace a “crooked” line: indeed, after some unfortunate experiments, we decide to to employ two crooked lines that cross each other. This marks the birth of the model of reference that “turns” ten vertical tiny lines (perception) into a sign formed by two tiny crossed lines (action). When we see that sign on our stone, we know that it corresponds to a certain precise number of lines. In order simplify the computation, we have traced the new symbol with the corresponding number of lines on the lower part of the stone (since the new system saved us a lot of space), hence, every time we see it we won't make any mistake... later on we will memorize it but for the time being we'd better not risk.

At this point, the model of reference “sum” acquires a new meaning inasmuch as, regardless of how we decide to represent it, it is no longer a mere aggregation, but its sharing (and thus its understanding!) requires a further agreement, namely an additional model of reference that associates IIIIIIIIII with X. The precise correspondence of this new meaning of “sum” can be easily represented within our one-dimensional universe to which we have conveniently added the state 2. If our system perceives 111111 (six states 1) and 11111 (five states 1), it won't have to “deliver” 11111111111 (eleven states 1) but rather 21[99] (one state 2 and one state 1). For the sake of giving an accurate description of the functionalities of our model of

Fig. 10.9. Sum as aggregation and sum with two active states.

reference, we may say that it "aggregates the values in input and each time it encounters ten cells of state 1 it converts them into one cell of state 2". This simple operation could be accomplished in several ways that we are now going to examine in detail.

Human culture, so exquisitely layered over the centuries, provided us with many ways to arrive at the concept of "summation". From the standpoint of the mathematics of the models of reference, no one method is better than any other, what is really important is that, before formulating any reasoning, you sholud enunciate the primitive concepts that will be employed and by means of which all the others may be derived. Let us begin to introduce the notation used in our research laboratory: primitive concepts (namey the axiomatic models of reference) are enclosed between square brackets, while derived concepts are placed between braces. Let us assume as primitive concepts the notions of [unit], [equate] and [aggregate], which are appropriately defined within our discrete universe STQ

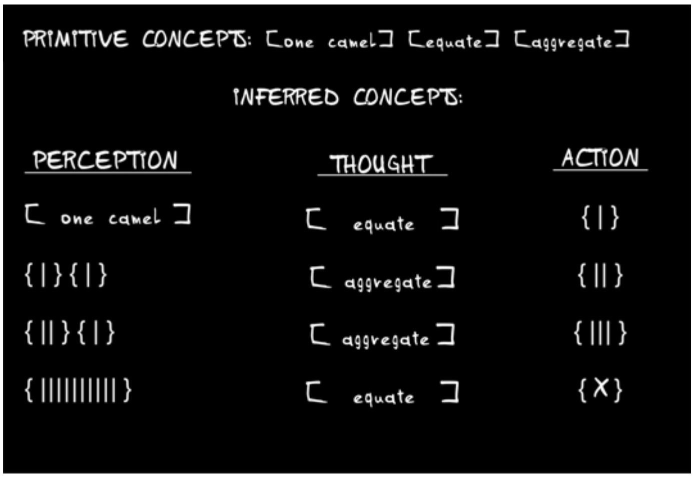

Fig. 10.10. Primitive concepts and derived concepts.

(space, time, states), and derive {I} as [unit] [equate]. We will therefore have {I} {I} [aggregate] determining {III} and so on. At this point, we are able to introduce {X} as a derivation of {IIIIIIIII} [equate]. One concept that must be well understood is that we might as well have used [one camel] instead of [unit], we might have employed {2} instead of {X} and, by the same token, instead of [equate] we might have taken two different primitive concepts, such as [symbolic representation] to "associate {I} with [unit]" and [equivalence] to "substitute {IIIIIIIII} with {X}". Obviously, we might also have employed {2} instead of {II}, {3} instead of {III}, etc… There are no a priori rules, everything is arbitrary, the fundamental thing is to agree upon (and hence communicate) the axiomatic models of reference and derive all the rest accordingly.

The steps from [one camel] to {X} do not in any way allow us to carry out the steps backwards (how to derive {IIIIIIIII} from {X}), unless we introduce a new model of reference {inverse equality}so that every time [equate] occurs, it is followed by the automatic (we might also say implicit) activation of a second [equate] where the previous roles of peception and action are switched. The introduction of {inverse equality} enables us to smoothly derive (and thus understand) “ten camels” from {X} and no only {X}from “ten camels”[100]. Let us dwell on the step {IIIIIIIII} [equate] {X}. Without {inverse equality} the step {X} [equate] {IIIIIIIII} would not exist, unless it were explicitly stated. Moreover, again for the fans of the genre, the model of reference “inverse equality” is a particularly interesting type of model. In fact, it may be conceived as a sort of metamodel inasmuch as it doesn't directly operate on an individual process, but rather on the structure of another model of reference and hence its definition requires the introduction of some form of self-referential capacity into our universe. Here we are dealing with a huge evolutionary step, to which we ought pay due respect.

Now, we return to the notation conventionally employed in our research laboratory and we introduce a new typology of models of reference that we might define “symbolic”, and that are enclosed between greater than symbol and less than symbol and a pair of round brackets where we will denote the totality of “perceptions” and the totality of “actions”. Therefore the model of reference “inverse equality” can be characterized as follows:

(<perception>[equalty]<action>){inverse equality}(<action>[equality]<perception>)

The model of reference <perception> directly depends on a structure, i.e. a *pattern*, and it represents something that might be defined as “the value taken by perception”. Therefore, from a mathematical standpoint, such notion is very close to the concept of variable, for it is a sort of label that does not depend on the content. From an evolutionary point of view, we have now entered the domain of second-level symbolic manipulation. By associating {I} with [one camel] we have constructed a symbolic universe characterized by the precise respondence between well-identified elements of the physical world and well-identified elements of the world of information. By introducing {inverse equality}, and therefore <value taken by perception> and <value taken by action>, we have performed a symbolic manipulation of our same symbolic universe. We might say that, at the first level, our eyes have seen [one camel] and our mind has assigned it {I}. By the same token, at the second level, "our mind's eyes" have seen [one camel] [equate] {I} and our mind has triggered {I} [equate] [one camel] by means of the metamodel {inverse equality}. Whenever we encounter and reflect upon this remarkable evolutionary step, we feel moved by it.

The ultimate goal of this chapter is not to present an organic exposition of the mathematics of the models of reference, rather, the main focus is letting you become familiar with the concept of model of reference itself, and, in particular, with the various computational implications. Therefore, we will skip some steps, which the patient and interested reader should by now be able to derive autonomously, and we finally land in the vicinity of a concept of "summation" that is computationally usable. We expect most of the readers to be dazzled by the number of implicit models of reference that are necessary to formulate a complete definition. Thus, let us start from the end, here is a possible model of reference "summation":

(<symbols><significativity><metrics><zero><maximum><values>)
{summation}(<result>)

As a starting example, we will employ the first six uppercase letters of the standard Western alphabet, i.e. A, B, C, D, E and F as <siymbols>. Then, we can assume a left <significativity>, namely the most significant digit is the most left-hand one, a "regular" <metrics>, the non-existence of "zero" and the non-existence of a "maximum" expressible value. Now, let us agree upon the model of reference “summation” in order to obtain the following working scheme: A+A=B, A+B=C, A+C=D, …, A+F=AA, A+AA=AB, A+AB=AC, etc…[101] It is quite straightforward to arrive at such working scheme by means of a certain number of different algorithms (at this stage, where the time factor is not critical, there isn't necessarily any algorithm better than any other, the important thing is that the “action” performed by our model of reference is exactly the one we have agreed upon[102]).

(

{ A B C D E F }

{ left significativity }

{ regular metrics }

{ no zero }

{ boundless expressibility }

{ A A }

)

{ summation }

(

{ B } *or* < result >

)

When a model of reference is “evoked” it remains active until it is modified. Therefore, it might be useful to intoduce the model of reference “kuru cultural conventions”:

(

{ symbols}

{significativity}

{metrics}

{zero}

{maximum}

{kuru culture }

)
{ kuru cultural conventions }
(
{ A B C D E F }
{ left significativity }
{ regular metrics }
{ no zero }
{ boundless expressibility }
)

Therefore, our model of reference "summation" might be articulated as follows:

({kuru cultural conventions}<values>){summation}(<result>)

Hence, just to make a few examples, we will have:

({kuru cultural conventions}{ B B }){summation}({ E })
({kuru cultural conventions}{ A C B }){summation}({ F })
({kuru cultural conventions}{ D F }){summation}({ AD })
({kuru cultural conventions}{ ABA CF }){summation}({ AFA })

Now, let us hypothesize the existence of a {maro culture} which is characterized by the use of the symbols "1234567890", but which is identical to the { kuro culture} in every other respect. Given the same model of reference "summation" we will have:

({maro cultural conventions}{ 2 2 }){summation}({ 4 })
({maro cultural conventions}{ 3 2 4 }){summation}({ 9 })
({maro cultural conventions}{ 8 4 }){summation}({ 12 })
({maro cultural conventions}{ 121 39 }){summation}({ 160 })

Now we can make head or tail of all this, can't we? Nevertheless, it might be dangerous to draw easy conclusions; in fact, let us consider the perception "1 + 0". According to the {maro culture}, the action will be "11" and, even more oddly, "0 + 0" will lead to "21". In order to truly get our bearings, we must assume the {pero culture}, which is identical to the {maro culture}, but where there exists the model of reference of the "zero", and thus where {yes zero}[103]. It follows that:

({pero cultural conventions}{ 2 0 }){summation}({ 2 })
({pero cultural conventions}{ 9 1 }){summation}({ 10 })

At this point, we have acquired all the elements we need to devise a variety of possible situations where the model of reference "summation" remains constant, while the models of reference "cultural conventions" vary. We can meander from the classic {binary culture} where the symbols will be "10", to a particularly creative one, say {piropiro culture}where the "zero" does not exist, and the symbols are the twelve syllables "ka se mu zo fi da re lu go pi va te" [104].

10.1 A mathematics of thought?

It's fair to say that the mathematics outlined in this chapter is not particularly innovative compared to the various mathematics previously developed, except with respect to a few, so to speak, "converging nuances". The total arbitrariness of the starting axioms is a useful conceptual tool, but it is far from being a novelty in the field of logic. From a mathematical point of view, the concept of model of reference closely resembles those of "operator" and "algorithm" and, again from a mathematical perspective, the rejection of the concepts of "infinity", "empty set" and "perfect identity" is an inevitable implication of a discrete view of the universe. It is possible to identify numerous points of convergence also with set theory (in particular its axiomatic version), with topological spaces "from Henri Poincaré onwards) and with the "machines" of Alan Turing and of John von Neumann. Also the possibility to "take a zoomed picture" of any dimensional level is typical of other mathematics, most notably fractal mathematics. Finally, the notation employed is clearly a product of the experience with several programming languages, most notably C#.

Nevertheless, these "converging nuances" allowed us to overcome that capital computational boundary that separates a "computable" (and thus reproducible) idea and a purely "tendential" idea. The mathematics we have developed has the ambition to set itself "before" our logical, analogical and realizational minds. Someone, after accomplishing the difficult task of understanding it in its essence, has defined it as a possible "mathematics of thought".The fields of application are numerous. Of course, our research laboratory has primarily engaged in investigating the spheres of artificial intelligence[105] and psychoneurophysiology[106]. The closure of the chapter will however be marked by a "lighter" tone with some hints of the geometry derived from the mathematics of the models of reference on the one hand and with a few likeable "artistic derivations" on the other.

Let us consider a two-dimensional space composed of hexagonal cells and seven states (one for each possible direction, plus the state "no motion"). We will conventionally assume that, with respect to the observation plane, the state "1" represents a motion to the "right" and that the other five states are expressed according to an anticlockwise progression (therefore, 4 will stand for a motion to the "left"). Furthermore, we assume the single cell to be endowed with an adequate memory capacity, so we will not be preoccupied with the number of "moments" that can be stored.

We are now ready to make our cells "draw" the first elementary geometric figures. A cell that is of state "135" will draw a triangle, a cell of state “1542” will draw a parallelepiped, a cell of state “123456” an hexagon, etc… If the cell of state “135” were “affected” so that its state were to change into “153”, we would obtain the equivalent of a 180° rotation in a Cartesian space. It is fairly uncomplicated to observe that, at a primitive dimensional level, only six rotations (multiple of 60°) are possible and that, again at a primitive dimensional level, the equivalent of the square and of the circle do not exist. These two figures, like any other figure or type of rotation, can only be obtained as approximations at higher dimensional levels. This is a cardinal concept underlying the geometry of discrete universes: regardless of the shape of the grid under consideration, the appearance of certain geometric figures is related to the increase in dimensional complexity and however it can only be obtained by means of approximations. We should not be scared of this concept, forasmuch as, on a practical ground, nothing changes with respect to the geometries of continuous universes: it is sufficient to think, just to give two examples, about the incommensurability between the radius and circumference of a circle and between the side and diagonal of a square.

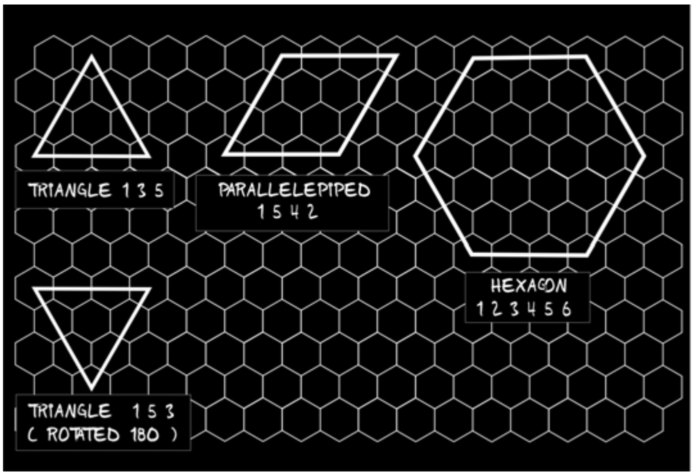

Fig. 10.11. Elementary geometric figures.

Now, let us return to focus on our elementary hexagonal cell, the ultimate principle of our discrete two-dimensional universe. It must be stressed that all the following reasonings may be equivalently applied to the rhombic dodecahedric cell of a three-dimensional universe. Nevertheless, the two-dimensional universe has the valuable advantage of being readily understandable to most people. As we have already mentioned above, our elementary cell can move in only six possible directions that are multiple of 60° in a Cartesian space. In order to increase the degrees of movement we need to consider a "bigger" hexagon. For instance, the hexagon of state "112233445566" will have twelve possible directions (30°). More generally, the hexagon of side L will have "L x 6" possible directions (with respect to the central cell of the hexagon). It must be borne in mind that we are analyzing the lowest dimensional level of our universe, which is plausibly equivalent to 10^{-35} of our physical world. We would only need to go up a few orders of magnitude to obtain slightly all the directions measurable with the most sophisticated tools available today. An hexagon of 60-cell side (10^{-34}) would display a one- degree movement accuracy. If we placed ourselves at 10^{-30} we would have an accuracy of one ten-thousandth of a degree. By moving up until the dimensional level of physical reality which we are presently able to investigate (10^{-15}), we would be confronted with an accuracy of movement that no equipment would be able to detect, not even remotely. Consider a cell of state "1xL 2xL 3xL 4xL 5xL 6xL" (where L is a direction relay), we therefore obtain an hexagon of side L. If the state remained unchanged over time, then the cell would continue to move indefinitely in a sort of hegagonal orbit at a distance (L-1) from the central cell. In the presence of any perturbation in the state of the cell, we would get some kind of motion in space. Let us now examine in detail the example of a cell of state "111222333444555666"(hence with L=3). We can easily verify that it will draw an hexagon of four-unit side at a three-unit distance from the central cell. At this point, it is as straightforward to show that we might move the whole figure by seven units to any direction, thereby positioning the new center of the hexagon in one among 42 possible cells and potentially occupying any contiguous cell without any solution of continuity.

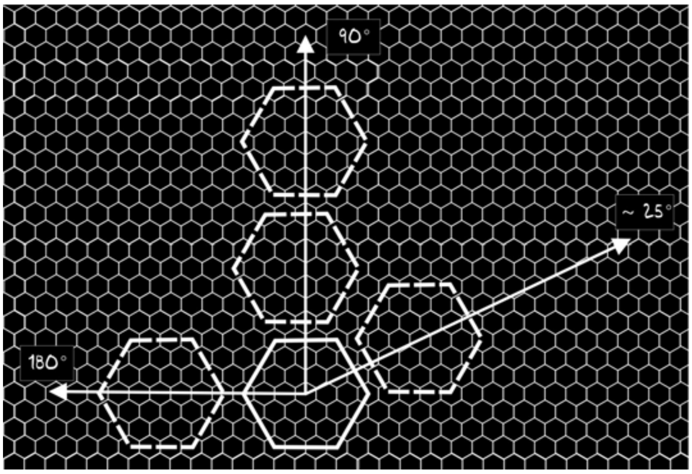

Fig. 10.12. Anglesi of motion in a discrete universe.

If we think in terms of Cartesian space, a cell of state "6661112223334445554444444" will draw an hexagon in a 180° continuous motion (namely to the "left"). By the same token, a cell of state "3334445556661112221112222" will draw an hexagon in an approximately 25° (25,7142857°to be precise) continuous motion. Of particular interest is the case of the hexagon moving by 90°. An attentive examination of the "fabric" of our universe shows the difficulty of obtaining a 90° motion (from here stems the non-existence of the "perfect square" in a discrete hexagonal universe). Nevertheless, as we saw earlier, motion can be approximated by increasing the side length of the hexagon to approach the desired angle, applying a concept very close to the notion of "limit" in standard mathematics. Yet, this is not the only way to proceed! In fact, it is possible to achieve the 90° angle in two steps. At the first step, the hexagon will move by slightly more than 90° (94,2857143°) and at the second one, by slightly less (85,7142857°),857°), thereby precisely resulting in a 90°motion with respect to the starting point.

By now, we have acquired all the conceptual tools necessary for "drawing" and "moving" any geometric figure, even the most bizarre one, within our universe. Furthermore, it wouldn't be a complicated task to artistically add a touch of colour, with each different colour corresponding to one of the seven possible basic states. But this is not it. In fact, it is possible to move into a further "creative dimension" by introducing some "collision rules" that lead to the change of states of the cells and thus to the subsequent modifications in shapes and trajectories. Certainly, something that the fans of the genre will be able to enjoy…

[92] The winter of 2007 was anomalous from a climatic standpoint in a considerable part of Europe. In particular, the area of northern Italy was characteried by unusually mild temperatures and the first flowering trees began to bloom already around the end of February. The landscape of the countryside looked particularly bizarre, many plants were still exhibiting a markedly wintery appearance (namely, they had decided that they were still in the middle of winter) whereas several others had taken that multicolor look that i typical of early April (thus, they had decided that the were already in spring). Leaving aside both the oddity and a certain scary charm of the landscapes, the scientific explanation to such phenomenon is fairly obvious and it is related to the plants' different degrees of sensitivity which is written into their genetic code and selected through evolution. Those plants that are able to more accurately interpret the climatic signals enjoy an advantage over the others. A sudden freeze in mid-March would seriously compromise the health of the "optimistic" plants (thereby reducing to zero their chances of reproduction), whereas they would benefit from a more predictable climate trend. From the standpoint of the mathematics of the models of reference, the single plant may be considered, at a macro level, as a system that perceives a series of parameters from the external world (temperature, humidity rate, light intensity, etc…),these parameters are assessed by the plant (thoughts) and they trigger the mechanism of flowering or they do not do so (action). At a slightly lower level, there are the individual receptors (such as those responsible for the temperature) that will give their evaluation as to whether it is convenient to activate flowering or not. At a computationally even lower level, we find specific quantative thresholds according to which a certain temperature, perhaps if extended for a given period of time, determines whether or not to favour a certain decision. But let us move to an even ower level: how can we precisely determine the "threshold function"? For example, we shall need to compare temperature values that are written into the plant's DNA and stored somewhere within its "information" system. And so on, in a reduction to the infinitely small which, in our opinion, from a physical point of view, terminates at the level of the various cells that are involved in the process, while, from the standpoint of information, it ends at the level of the operators and basic data. Now, let us move to the human domain to analyze any one decision, from the choice of the tv show or the book accompanying our evening, to the purchase of the house we will live in. The mechanism remains the same: the final decision will be the result of a path that

is often complex and layered, frequently double-checked, but however referable to the concept of "perception => thought => action". The action may be underlaid by very different levels of cognitive complexity, yet, in essence, behaviours such as signing a deed or pressing a remote control's button are all triggered by models of reference, and thus by previously experienced perceptions. If we could economically afford to purchase a house every evening, then there would be no great difference between the two examples; quite the opposite, we have seen particularly "skilled" remotes whose correct use requires the involvement of a certainly higher number of models of reference with respect to those that are necessary to purchase a house.

[93] These definitions use the term "caused" to denote the deterministic consequence of the application of the rules of the universe which the system belongs to. This semantic choice precisely reflects an objective and impersonal vision of the becoming of the universe according to which everything is "caused" by the Big Bang (or whatever we mean by it) and by the laws of the universe, hence it is to be understood in this context. For a more detailed explanation, the reader may refer to the chapters "The physical universe", "Reality" and "The systems".

[94] With reference to arbitrariness, the "right side" of a cell may equivalently be determined either by considering the cell's reader-facing facet or the page-facing one as the active facet. We have opted for the first convention. In other words, the right side would correspond to the East of a hypothetical compass where the North coincide with the "top side".

[95] From a strictly formal point of view, the mechanism is slightly more complicared because if we assume that our universe is characterized by only one rule (namely each cell inherits the state of the adjacent cell on the right), then the return from state 1 to state 0 is, in turn, to be considered as a second model of reference (which will occur at the times t+2, t+3 and t+4). The introduction of a second additional rule would remove the necessity for the second model of reference (for instance, we may add the rule according to which, after taking state 1 at a certain time, a cell automatically assumes state 0 at the next time period). The informational correlation (in the sense of information content) among states, rules and model of reference is a typical feature of the universes that are constructed according to our approach, hence it is often encountered in the various examples and simulations.

[96] Nothing forbids us to think that, at the ulltimate level, this is precisely how our universe functions … for the sake of accuracy, the constraints are even "softer", in fact, it would be sufficient that the various sizes of the states of the cells were submultiples of the size of the absolute counter and that the appearance of any new cells (whatever that may mean) occurred at the restart of the absolute counter.

[97] In just a few line the term "primitive" has been used with different acceptations. At this stage of the reading, the reader is not yet able to fully understand what is the second meaning involved here. The quotation marks around the word are there to alert the reader of a possible second meaning. A few lines earlier, we had employed the term "primitive" in a logical-mathematical sense, and soon we shall use it in a historical sense, resorting to a play on words that is commonly used in a speeech. Why does a person generally have no difficulty in understanding a pun, or why is she even able to appreciate the diverse nuances in the prose of a talented writer (as well as actually enjoy reading)? The answer lies in the fact that the context triggers the models of reference and it is thanks to the activation of the models of reference that a person "understands" what she is reading.

[98] Those silly primitives of the tribe nearby, have been asking for yers how we manage to systematically uncover them… in strict confidence, but don't tell anyone, there are times in the morning when we find ourselves with a few more camels without any baby camel being born, we sought an eexplanation from our ruler who told us not to worry and to keep on readjusting the stone with the corresponding lines…

[99] Or, alternatively 12 (one state 1 and one state 2), at this moment there is no difference whatsoever between 21 and 12.

[100] This observation is far from trivial as it would be perfectly possible to construct a fully functioning universe where the concept of "inverse equality" does not exist we may even dare to say that, from a philosophical standpoint, we have never been entirely convinced of the concept of "perfect identity", which is in many respects analogous to the notions of "equality and inverse inequality". It is a useful "tendential" logical category but we don't think it exists

in the real world, just a there do not exist infinity or nothingness. As already pointed out by Gottfried Leibniz *a* equals *b* only if all (all indeed!) the predicates that apply to *a* also apply to *b* and vice versa. It should apper clear that, in its strictest acceptation, such concept is not present in reality.

[101] For the sake of ease of reading, we have used the standard mathematical symbology (i.e. the model of reference "standard mathematical symbology"!) to illustrate the scheme of operation we refer to as "summation". It should be fairly clear that we could have defined it in a rigorous manner and without resorting to "external help", but at the cost of sacrificing a substantial amount of expositive clarity. Translating the example into a more familiar set of symbols, we will have: 1+1=2, 1+2=3, 1+3=4, …, 1+6=11, 1+11=12, 1+12=13, etc… That is something which closely resembles the system we are more accustomed to, except for the fact that it uses the base 6 rather than the usual base 10.

[102] Nothing would prevent us from using, for instance, standard mathematics algorithms relying on a base-10 numbering system as primitive models of reference . Although aesthetically objectionable, this solution would involve a significant advantage as it would be computationally efficiently implemented in programming languages such as C and Basic. For example, a hypothetical " ABA + CF " may be converted into the equivalent form " ($1 \times 6^2 + 2 \times 6^1 + 1 \times 6^0$) + ($3 \times 6^1 + 6 \times 6^0$) ", namely " 49 + 24 ". The result " 73 ", as efficiently calculated in base 10, would then be converted into " AFA ". From the standpoint of the mathematics of the models of reference, it is an admissible solution inasmuch as there are no a priori constraints to the definition of primitive models. Nevertheless, a hypothetical primitive model of reference "summation of two base-10 numbers in the C language" is an imperfect model of reference since it intrinsically contains a limit to its maximum numerical expressibility (i.e. if we wanted to add any two, even very large, numbers, we couldn't use it as primitive model). There would be a lot to reflect on in this example. Primitive models of reference that are "inherited from others" may be very useful in terms of usability, yet, almost always, they involve some sort of "original flaws" which are well known to the creator of the model, but which are not easily predictable by the user. This concept may indeed be extended to any model of reference, be it mathematical, ethical, cultural, ideological, etc… From here the convenience of developing "one's own primitive models of reference" (of

course, benefiting from the experience of those who have preceded us) in the attempt to get as close as possible to the essence of the various concepts. An explanation to students of whatever order and field which is solely focused on the mere concept of "base-10 summation" implies a substantial departure from the essential understanding of the concept of summation. In nearly all cases, this implies to lose the ability to appreciate the beauty in the technical invention of the "zero" thereby confusing it with the concept of "nothingness". The most severe consequence of this kind of error, as repeated countless times throughout the traditional academic path, is that most students are irreversibly pushed away from one of the most fascinating and useful subjects.

[103] The introduction of the model of reference "zero" is closely related to the algorithms used to operate the model of reference "summation". Why would our great-great-grandparents ever have had to devise the zero? It was only for technical reasons! In fact, the "0", understood also as "zero" and only as "ten", allows us to put two numbers into columns and add them up with great ease, as we have been wisely taught in elementary school. This operation wouldn't have been possible without the concept of "1+0=1". For instance there is no "zero" in Roman numerals. By the same token, a computer or a highly developed human civilization in terms of computational abilities could well do without the "zero". Had you ever thought about it before? As far as the ultimate concept of "summation" is concerned, zero is an anomaly. Why is it that "9+1" equals "10" while "9+0" equals "9"? It appears clear that the symbol "0" has one meaning in the formert case and a different meaning in the latter. We are so accustomed to the model of reference "summation of two numbers as learnt from our elementary school teacher" that we don't even notice it any more. Nevertheless, it is pure convention and, if we are to tell you the whole story, we also believe it is aesthetically questionable, no offense to our Indian and Arab ancestors intended.

[104] The "piropiro" culture has developed on a distant planet populated by two different ethnic groups, perpetually at war with each other. The main difference dividing the two groups resides in the model of reference "significance": the Western ethnic group has adopted a "left" significance, whereas the Eastern ethnic group has opted for a "right" significance. Though they are saying the same things, they just fail to understand each other!

[105] From the standpoint of artificial intelligence, the mathematics of the models of reference is driving the development of a programming language, which is directly derived from it. This language has enabled us to start to handle with relative ease a number of steps along the "spiral of knowledge". Right now, we are in the process of trying to identify the essence of the actual primitive models of reference of the human mind, namely those that underlie all the subsequent triggers. We are considering an interesting number of possible candidates and the consolidation of effort with the research project on i-ese (i.e. the new universal language developed by our research laboratory) has brought an additional acceleration to the project which allows us to be optimistic.

[106] From the perspective of psychoneurophysiology, we expect the mathematics of the models of reference to be able to provide a significant contribution to the identification of the underlying mechanisms that trigger the onset of a number of psychophysical discomforts that often heavily affect our daily life (anxiety, headache, addictions, allergies, etc…). If we consider any one "undesired phenomenon", such as anxiety, as a model of reference that is triggered by a well-defined series of "perceptions" (i.e. particular events related to the personal history of each one of us) which causes a specific series of "actions" (sweating, obsessive thoughts, tachycardia, increased blood pressure, etc…) it should be easier to effectively intervene by activating a new model of reference aimed at deactivating, or "diluting" the previous one. In fact, the decomposition of the process into its primitive components should allow us at least to "understand" it, while the stimulation of those self-referential abilities that are inherent in each person, should facilitate the solution process.

PHILOSOPHY OF SEMI-IMMORTALITY

11. Reality

The concept of *Reality* basically encompasses the concept of the existent.

Throughout the latest years, physics, genetics and computer science have provided critical contributions to the understanding of the nature of *Reality*. We believe *Reality* to be composed of both the things we touch or see (hardware) and of what we think (software). From our standpoint, matter and information are two closely interrelated ways of interpreting *Reality*.

Each one of our thoughts leads to a change in the state of our brain that can, for instance, command our hand to action. Analogously, a software instruction involves the modification in the state of computer memory, which can, for example, send a message to the printer. Considered from the other direction, a physical change in our brain modifies our thoughts, just like a modification in computer memory implies a change in the program. Any alteration of the information contained in DNA results in a change in the physical development of the organism. Thoughts are able to alter the chemical composition of our blood, on the other hand, the chemical composition of blood can modify our thoughts. According to our approach, we can assert that "everything is matter" just as we can maintain that "everything is information". It all depends on what standpoint you look at it from[107].

We deem it possible that *Reality* is composed of something that resembles a huge matrix of minuscule three-dimensional cells that simply change state according to a few underlying rules. We therefore assume that there is no motion within our universe, but merely the change of state of the elementary (conceptually indivisible) cells. Hence, there also exists a unit of time (which is conceptually indivisible itself) separating one state from the next. Between the two states there would be a sort of potential state wherein the successive states of all cells are computed and any possible conflict resolved.

Forasmuch as we don't yet conclusively know what is the ultimate nature of our universe, any model is just as good as any other. The model we now propose has the advantage of being simple and, at the present state of our knowledge, of not being incompatible with any known law. For the purposes of this book, the important point is to identify a definition of *Reality* which is consisten with the model, regardless of the model adopted.

Reality does not only consist of the basic elements of matter (whatever that means, namely our changing-state cells, rather than the waves and particles of quantum physics or the ten-dimensional superstrings). In fact, it is also made of the laws governing the behaviour of such elements. In our model of universe, it will be the laws to determine the change of state of the cells from a time t to a time t+1. In other models, we will have the law of gravitation or the equation that links mass and energy.

The application of the laws to the states of the elements determine the evolution of *Reality*. We expect the fundamental laws and elements to be very simple, if not unique. Therefore, the *Reality* we are part of is composed of aggregates of elements and laws that appear to our eyes in a variety of different combinations.

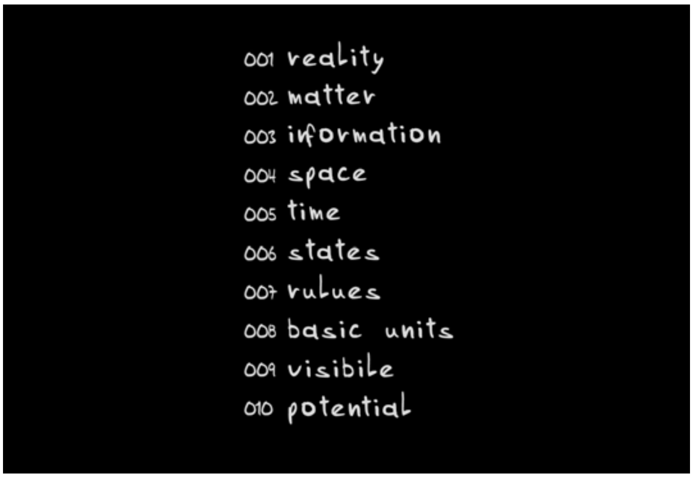

Fig. 11.1. A few innate concepts related to *Realty*.

11.1 *Reality* as an approximation

Reality functions according to well-defined laws and elements that we observe and that we are necessarily forced to aggregate and approximate. When we look at a cat running down the street, what we see is "a cat" (whatever that means), and not a collection of molecules, or particles or cells that change state. When we predict the direction it will take with a reasonable degree of approximation, we are applying some macro-rules of motion, which are partly innate and partly acquired through experience. For sure, we do not directly observe the amount of energy. And we are even less able to read the flows of thoughts of the cat with respect to some eligible prey, which is precisely what, in a few seconds, will determine a sudden change of direction.

Such approximation stems not only from our lack of knowledge regarding the functioning of *Reality*, but also from our bounded sensorial and processing abilities. Only the contribution of machines will allow us to improve our limits. This approximation is inevitable, but also fairly efficient as far as our daily life is concerned, nevertheless it must be borne in mind that it is a constant source of errors with which we must learn to coexist. And what, sooner or later, leads us to death is the accumulation of these errors. As far as semi-immortality is concerned, errors will probably remain unavoidable for a long time to come. Our view is that over the next few years we will learn to correct an ever-growing number of such errors.

11.2 *Reality* as an act of faith

We assume *Reality* exists regardless of whether we think of it (information) or we observe it (matter).The logical part of our mind conceives such passage as a formal weakness. In fact, we are relying on an assumption that, at the current state of knowledge, by definition, we cannot prove[108]. And, just as this were not enough, Werner Heisenberg came up with his uncertainty principle showing us how difficult, if not impossible, it is to know it in its entirety[109].

It is only thanks to the analogical part that we can overcome this obstacle in probabilistic terms. At any rate, the realizational part would prevent us to get caught in a sterile logical *loop*. The logical component itself somehow manages to withstand this step inasmuch as, ina accordance with Kurt Goedel, it finds it impossible to elaborate an unchallengeable formal system... there will always exist some true but unprovable propositions within it[110].

Basically, this book aims at being prevalently "realizational" in nature, therefore we have tried to adopt a sound formal approach without neglecting that our underlying assumptions mainly stem from analogical reasonings. Moreover, we kept in mind that our ultimate goal is the achievement of semi-immortality and that our path is studded with intermediate objectives, such as favouring the treatment of body through the mind and realizing the artificial-Selves.

We believe that a crucial step towards the necessary neatness of reasoning is to set order in the domains involved. We are convinced that the theses we present here are free of any attached emotionality. We hold no interest in supporting this rather than that hypothesis. What we seek is simply to identify those hypotheses that, within a framework as coherent as possible, do work better.. For instance, in accordance with Albert Einstein, we consider the theoretical model of quantum physics inaccurate. Useful, yet inaccurate. When we uncover the even lower level of the laws of matter, we envisage that the concept of probability will no longer be necessary. Such thesis builds on the analogical reasoning. The logical scrutiny leads nowhere, neither for those who agree with us nor for those who maintain just the opposite. And, in the meantime, we all properly use the realizational reasoning and, for example, we exploit the theory of quantum physics to make phone calls thanks to satellite technology[111].

11.3 Towards the understanding of the rules

The main problem of discussing such topics in an informal manner precisely resides in the use of language as a communication tool. By way of explanation, it lies in the very meaning of the words being used. We should stop and define a new language, namely one that is as close as possible to the innate language of our species, what Steven Pinker denotes as "Mentalese" [112]. While waiting for this to be both accomplished and broadly accepted by our species, we are forced to employ languages whose words have ecocative and often non-univocal connotations[113]. For instance, when we read the word "love", a huge variety of triggers of meaning are unleashed in each one of us and they are often quite different from person to person, not to mention the heterogeneity among languages. To minimize possible ambiguities, we will constantly engage in the attempt of associating the key word with its Mentalese counterpart; we do not know whether we will be able to perform such operation in a generally satisfactory manner since we will inevitably rely on our native language, the books we've read and the phrases we've heard. We will try to be as neutral as possible. We have considered the option of using prime numbers (as proposed by Gottfried Leibniz[114] back in the seventeenth century) or the new language we are developing in order to facilitate man-machine conversation[115], but perhaps we would only have made things unnecessarily more effortful for the reader. We have also thought over employing words from ancient languages (such as hieroglyphic Hebrew, classical Greek, Sanskrit or Latin) but we have failed to favour one over the others[116].

However, the dangers implied by the use of language as a communication tool are not only those related to semantic ambiguity. The second major problem is the confusion of levels. Quite often, apparent contradictions or incorrect inferences are resolved by reinstating homogeneity in the levels of reasoning. For example, I may state that "this sentence is false". At a first level, such proposition is neither problematic nor does it give rise to any contradiction: it is merely a statement. In order to bring out the contradiction, or more precisely its logical *loop*, we have to ascend to a higher level, namely the level of its meaning (that is, we have to observe it from above). We must employ models of reference that belong to different levels. If we break the sentence into all of its elementary models of reference, the second-level contradiction obviously persists, but the logical *loop*[117] is removed. This type of problems has been cleverly brought to the extreme by many philosophers starting from Zeno and his turtle[118]. It should be noted that the problem of the confusion of levels is also present in the everyday common language. How often we formulate statements that do have a certain meaning in a given context, while they would be completely incorrect if immersed into another one. Everything depends on the models of reference we use to generate the sentence and which tend to be fairly shared by the listener in that particular moment.

The third serious problem, perhaps the most dangerous one, is that of the overlapping of domains. We may try to be as rigorous as possible in our analyses, to pay the utmost attention to the careful definition of all the words and to preserve the homogeneity of levels. Nonetheless, a nearly irresistible force will drag us into the overlapping of domains. This occurs because in our mind there coexist at least three reasoning tools that belong to distint domains, i.e. the logical, the analogical and the realizational spheres. Evolution led us to specialize in all of the three areas, thus it is difficult to keep them disentangled. Also because such solution would probably be an ineffective one. Colloquial language in itself brings together all the three components. If we didn't maintain the domains distinct, a book like this, despite its ambition of being as consistent as possible, would inevitably show some contradictory aspects. The description of the real and the operation of the human mind fall into the logical domain. The drive towards the pursuit of semi-immortality and the instinct of healing patients belong to the realizational domain. The *Prelude* and the *Finale*, which, at the end of the day, are the true roots of this book, appertain to the analogical domain.

Now we are ready to go forth. We have our model of physical universe. We know, at least in its general outline, how the human mind functions. We are aware of both the risks and limitations of informal language. Finally, we believe that the goal of life is to take part in a Game, the game consisting in understanding the rules of the game itself. From the *Prelude* it is possible to accurately derive our underlying axiomatic structure[119] (namely, the unprovable basis of all subsequent deductions).

In a Time difficult to pinpoint and in a Space difficult to specify, one or more Intelligences several orders of magnitude superior to ours decided to amuse themselves and generated one or more Universes.

In the first paragraph of the *Prelude* we place the reality preceding the birth of our universe outside the realm of the knowable. We suppose that our universe was generated by some forms of intelligence which we can say nothing about in a space-time reality beyond our comprehension. Such paragraph might be defined as a pictorial paragraph inasmuch as it adds no information, but it rather serves to outline a possible context to start from. At the present stage, this is the most we can say about the role of the originative intelligences, it has no implications on all the rest and it leaves the door open to the existence of other universes. Beyond any doubt, this is a contextual hypothesis, a product of our time and it is bound to evolve along with the progress of knowledge. From a formal point of view, it might be characterized as a backward projection of our basic axiomatic structure, something that goes like this: "if it is true that we are participating in a game, then there must be someone that created it". Yet, while we may later assign a meaning to the sense of our life so as to make it consistent with the starting assumptions, nothing certain can be said concerning the motives of the originators of our game. Bringing our identification with them to the limit, we can only conjecture a sort of decision to amuse themselves.

The subsequent paragraphs contain the axiomatic structure itself. It springs from the sum of all our knowledge and the best effort that our comprehension, projection and identification abilities could possibly provide .Obviously, the bibliography of the *Prelude* is monumental and it tries to take into account all the previous analyses of the topic[120]. The instruments of comprehension are primarily derived from the description of the functioning of reality, therefore they are rooted in physics, chemistry, mathematics and all the sciences connected with them. The instruments of projection mainly originate from the search for the ultimate laws and thus they are acquired from philosophy, art, religion and all the disciplines connected with them. The instruments of identification essentially stem from the study of the symmetry between reality and information and hence they have their origins in computer science, engineering, genetics and the technologies related to them. For those readers who have grasped the essence of the division into three domains, it will be a straightforward task to associate each of the three instruments with their respective domain of origin.

During the elapse of Time within the Universes one or more Systems developed and initiated one or more Games.

Each Universe is composed of one or more Base Elements and one or more Fundamental Laws. Recursive combinations of the Elements and the Laws determine all possible Systems.

The second and the third paragraph enclose the generalization of the starting assumptions. All the universes are composed of at least one base element and at least one fundamental law. Within each universe there exists at least one system that participates in at least one game. Every system consists of a certain aggregate of elements and its behaviour exclusively depends on the implementation of the laws. We are still in the domain of potential possibilities where nothing is yet defined about man nor about the game man is taking part in. We simply admit the possibility that our universe might not be the only one, that there might exist other fundamental laws as well as other systems and other games. Also our universe originates from the generalization of the universes, the systems and the games.

Within our Universe, nearly four billion years ago, on planet Earth the first Intelligent Systems developed, i.e. systems capable of elaborating non-univocal responses to external stimuli.

Within our Universe, roughly one million years ago, on planet Earth the first Systems Man emerged and began to take part in the Game.

On the basis of the information currently available, our universe has been existing for about 15.8 billion years[121]. Roughly 4 billion years ago, on our planet a few combinations of inorganic matter led to the appearance of what we tend to regard as organic matter, in other words the DNA[122]. Approximately one billion years ago, what is generally considered the DNA of our species[123] came to light. From an anthropocentric point of view, these are probably the most momentous events in the history of our universe, while we are waiting for the fourth one when our species will manage, if it ever will, to solve the Game. It goes without saying that the anthropocentric point of view is not the only one possible, even though it is certainly what we are most familiar with. A particularly interesting perspective is the "earthcentric" point of view, namely that of our planet considered in its entirety[124]. We cannot exclude that there might exist other systems that are participating in the game, and some of these systems might have man as subsystem or suprasystem. Another thought-provoking example is the "gene-centric" view of Richard Dawkins.

The Game consists in coming to utterly understand the rules of the Game itself, the Prize will be Immortality and the Complete Solution to the Game will enable the Systems realizing it to approach the Originative Intelligences.

This is the true starting point of our view, the central axiom from which everything originates and which the meaning of life and thus the key to understand the history of man, his present and his future, stem from.

Ever since his appearance Man has been building Machines for the purpose of assisting him in the attainment of the Complete Solution to the Game.

The Artificial-Selves we shall construct will be one of these Machines.

In our view, the machines that are created by man come to play a well-defined role. Without machines, we would never be able to thoroughly comprehend neither the reality surrounding us, nor the human mind. Without machines, we cannot think of solving the game: it is only thanks to them that we have any chance of attaining semi-immortality.

[107] Everything is matter, everything is information. Both the man in the street and the man in the laboratory know that the chemical and physical changes that occur within our body result in alterations of our mental states, be them conscious or not: medicines, drugs, diseases physically weaken or metabolism, and thus our mind; our mood, reflexes, the most diverse cognitive abilities may all be altered through the use of adequate substances. Nevertheless, both the man in the street and the man in the laboratory are aware of the other side of the coin: the modifications of our mental states produces alterations in the physical world. The memorization of a specific memory alters the biochemistry of the brain, just as it is the case when we feel a certain emotion or we read the pages of a book. Each conscious action causally depends on a belief, a desire, an intention; and more than that, each mental state depends on some previous mental state. Obviously, one thing to state that we know that something actually occurs, another thing is to explain it: men have always known that a billiard ball sets another billiard ball in motion, yet it took them centuries to develop a theory that was able to provide an explanation to such fact. The very first temptation of the philosopher (but of the scientist as well: think of the psychons) is that of taking the separation between mental and physical in a literal sense and thus trying to explain the interaction between the two substances. In this last category falls the proposal of René Descartes, who hypothesized that the mind (i.e. pure unextended substance) communicates with the brain through the pineal gland. A more refined approach was formulated by Gottfried Leibniz, who, while arguing for the difference between the substances, did not postulate any mysterious connections between them: causality is an illusion stemming from the prearranged harmony of the universe, just as two different clocks that have been loaded in the same way will strike the hour in accord, though without influencing each other. The second temptation of the philosopher is the "monism of compromise", namely the attempt to reassure ourselves of the fact that, basically, there are only physical entities in the world, while, at the same time, preserving the irreducibility of the mind by means of cryptic formulas (such as that of "emergent property", or that of "supervenient bur irreducible property"). Nevertheless, we deem it impossible to preserve the idea that the mental depends on the physical and that, at the same time, it may have some real, autonomous influence on what occurs in the world. The third temptation of the philosopher is that of a complete and utter monism: mental states do have causal efficacy forasmuch as thay are not distinct from the physical states and

thus, if we take the causal powers of the latter as non-problematic, then the problem of the influence exercised by the mental on the physical vanishes. The various versions of monism differ in what thay take as the building blocks of the universe: the orthodoxy is that of physicalism, according to which, in the world, there exist only physical objects and properties, however there are also other proposals. Of particular interest are the reflections elaborated by David Chalmers and the recent "it from bit" theories. The key underlying observation is that physical properties are characterized in relational and extrinsic terms, i.e. in terms of a dimension of "differences that make a difference": ultimately, we have informational states whose values may vary in some manner described by the laws. In other words, we find ourselves with the detailed description of the operation of the strings between nodes in a network, as well as the position and the behaviour of these nodes as the conditions change. Even Bertrand Russell , throughout a certain period of his life, had advocated a metaphysical theory called "neutral monism": the world would not be underlaid by either physical or mental properties, but rather by a different and more basic type of property. Russell had to deal with the problem of identifying intrinsic properties that would serve as the foundations for the causal relationships between physical quantities, while we are confronted with the issue of identifying something that would realize the informational states described by physics: as argued by Chalmers, it is the exact same problem and it can be solved in the same way, namely by postulating intrinsic properties ("proto-phenomenon") which are neither physical nor mental and which are able to support the causal structure of all the relationships that occur in space-time. Curiously enough, the philosophy of physics is far more speculative than traditional metaphysics and, of course, there is no general consensus on the idea we have just described. Beyond any doubt, what is not controversial is the pivotal role that may be played by information in helping us to build a clearer picture of reality, or more accurately, an informational level from which we may look at it. Conceiving computer's hardware-software interaction in informational terms opens up huge prospects: the physical level, namely that of silicon, does not allow us to make the right generalizations or to give a sensible interpretation of the overall behaviour of a system. We think it should be borne in mind that any modification in the state of matter (for instance, the magnetic memory of a computer) implies a contextual change in the information content and that, by the same token, any variation in the stored data(for instance, adding a new element to an archive) brings about a contextual alteration in the state of matter. According to our approach, such process analogously occur in the complex systems of living beings, such as man: the physical states and the transmission of information constitute the two key aspects with which reality is to be analyzed, and such aspects do not conflict with each other, but rather complement each other. As the isomorphism between a physical state and the informational state it realizes is guaranteed, we can switch from one vision to the othr without the risk of errors or loss of detail.

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[108] Reality as an act of faith. There are some beliefs that are so fundamental that they cannot be questioned. Or, more accurately, the negation of such beliefs is so paradoxical that its assertion must be supported by conclusive arguments. If a tree falls in a forest where there is no one, it will nevertheless make a sound; the world was not created some five minutes ago by an evil god who has filled it with people possessing fake memories and false evidence of the existence of a more distant past; even though I cannot be inside the head of my best friend, it is however very likely that he is as conscious and sentient as I am (or, at least, this is what I very much hope). Among the various ideas that are so intimately rooted in our view of the world, the existence of reality as independent of our own activities (i.e. thought and observation) may be singled out as the most "metaphysically" interesting and fruitful one. It can be referred to as fruitful inasmuch as it tends to (without needing it) a deeply "egalitarian" image of the world, where every existing thing is just as important as any other regardless of how we may consider it (the "scientific" image of the world seems to fall into this type). And it can be defined as interesting because many philosophers have found that defending this position can be far more problematic as it may appear at first sight. Our research laboratory accepts the existence of reality as the very first postulate, the inevitable act of faith underlying any investigation of reality as

well as the path towards semi-immortality. There is no accident in this: any attempt to demonstrate it will appear, at best, presumtuous and, at worst, impossible; taking such intuitive and potent an axiom as underlying our view of the world should ensure we won't have to resort to any further acts of faith in the prosecution of the work. It is important to remark that this setting allows to shield our studies from those criticisms that are based on too simplistic considerations: as it is an act of faith, we neither accept to discuss it nor to consider any possible modifications, unless there are excellent reasons to do so. Since, by definition, the issue cannot be settled by any empirical discovery, there seem to rmain only two possible objections to our strategy: the first rests on the possibility of having one (or more) alternative acts of faith able to guarantee a better and more fecund development of thought; the second consists in proving that our approach, while far from being uncontroversial, is even contradictory. Obviously, this latter option is far from straightforward: all a priori attempts to demonstrate the problematics inherent to the idea of a world independent of us seem bound to an inevitable confusion. More than that: even if we accepted the effectiveness of some among these arguments, no one of them seems to be sufficiently solid as to dismantle our confidence in this idea. In other words, it is reasonable to admit that we are far more "certain" of the plausibility of our postulate than we may ever be of the premises of a discourse which is aimed at refuting it. Different considerations apply to the first type of objection. In fact, as we have repeatedly emphasized, we stand ready to revise parts of our approach, should they turn out to be improvable by other, more fruitful ideas bringing about interesting implications with respect to our purposes. On the other hand, it should be pointed out how, in practical terms, it is not easy to even think about possible alternative acts of faith, both from the standpoint of conceptual economy, and from those of intuitive evidence and formal effectiveness. The fact remains that this question on reality is the only one we see as somehow logically unanswered. Fortunately enough, we are equipped with an analogical and a realizational mind that together allow us to bear the first and most fundamental fact of any branch of knowledge: we are not, and will not for many years, be able to prove everything.

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[109] In the context of quantum mechanics, each "observation" of a physical quantity is inevitably affected by a certain degree of undeterminateness in the measurement which is referred to as the "uncertainty" of the observable that is a probability function. For any two correlated quantities, the following important theorem holds: at a given time t, the values of two quantities g_1 and g_2 may be known with the uncertainties □g_1, □g_2, which are linked by the relation □g_1 x □g_2 □ h / 4□ where h is Planck's constant.

[110] In addition to the independence with respect to thought and observation, there is another philosophical aspect which comes close to our concept of Reality under several respects. When we speak of the "arbitrariness" of the systems, emphasizing that any possible configuration in the space-time is just equivalent to any other, we are opening the door to a markedly conventionalist view of the real. Our cognitive systems (which have evolved along certain lines) somehow allow us to systematically take into consideration only those portions of reality which are salient on a daily basis, for instance, there are those who "catfy" or those who personify", while neglecting all the others, with considerable cognitive savings: as a matter of fact, it is us who draw the boundaries of the "being in the world". While it is fairly uncomplicated to understand how the conventions create the everyday objects, more effort is required to accurately define the relationship between our boundaries and what we have taken to be the basic building blocks of the universe, namel the cells. At this point, we are confronted with two main philosophical options: we may either consider the cells as real and independent of our "mental lines", or we may conceive them as boundaries we have introduced into the real. These two versions of conventionalism, which share the basic philosophy and the underlying aesthetic taste, are equally defensible. Nevertheless, we deem the latter to be closer to our approach: first, there are the Real, the Whole, the Being (whatever all these may mean) and then the boundaries of thought and language begin to construct the objects of our world, including the cells. It is impossible to speak, or even think, in a "pure" fashion, namely unconnectedly to any of our own "conventional" and "arbitrary" creation of borders. The very concept of Reality, if conceived as a whole, cannot be a "pure" concept as it is itself subject to conventionality. Although this pushes towards the non-transcendence of language (anything we say is, by definition, part of a language and thus of a convention), it should be pointed out that it does so without drifting into idealism. The very idea of

boundaries makes sense only if we assume that Reality as a whole is given and exists independently of us: we do not create the world, rather we "arbitrarily divide it into objects".

[111] The wave-particle dualism is the foundational mechanism of quantum mechanics which is used for satellite telecommunications. A substantial part of "mainstream" technoogies such as Internet, mobile telephony and satellite navigation systems rests on the ability to generate, modify and characterize electromagnetic signals, and terefore light pulses, which are becoming increasingly shorter and more complex as the technology advances. On the one hand, electromagnetic pulses can carry information at the speed of light, on the other hand, they offer the opportunity to direct and guide the otherwise chaotic and unordered motion of the electons inside the chips that make up the everyday electronic applications.

[112] Mentalese. For centuries it has not been possible to explain how a four-year child could know thousands of words, be able to construct very complex propositions and, most of all, how he could have the capability of never committing certain errors as far as the linguistic structure of his communication was concerned. Noam Chomsky was the first ever to provide a scientifically satisfactory answer to such question by considering the hypothesis that the child's brain contains a sort of "universal grammar", namely a book of instructions which would constitute the foundation for learning all the languages of the world. Building on this idea,Steven Pinker came to explicitly speak of a "language instinct" resulting from evolution. In a nutshell, just as we are endowed with the instinct of hunger and thirst (with the relative genes), so we have some specific genes of language which are responsible for the creation of cerebral structures able to evolve so as to potentially "speak" any language in the world. Steven Pinker goes even further trying to give an answer to the interesting question about the relationship between language and thought. According to Pinker, there would be no real difference between these two dimensions of our mind/brain: to think means to manipulate representations, which are nothing but propositions. Nevertheless, such propositions are not written in English, French or Italian: no one of us thinks in any specific language, but rather we use an abstract mental idiom (i.e. "mentalese") that "informs" the thoughts thereby preparing them for the subsequent translation into our mother language (so that thought may become a part of reality in a causally effective manner). When a

system engages in thinking about any meaning, this appears to its mind in the form of a proposition in mentalese, which "corresponds" to what will then be pronounced with the words of a given language. Inasmuch as some organisms (such as neonates) think while not speaking any natural language, then mentalese would be an innate language as far as both the syntactic and the semantic component are concerned.

[113] The universal language. From the myth of Babel onwards, many of the most prominent thinkers have dealt with the problem of creating a universal language. Most probably, the initial drive is of a philosophical-conceptual nature: if there is one thing that seems hard to refute is the fact that we humans are very likely to possess the same concepts, even though we communicate them in different languages and resorting to dissimilar syntactic structures. Therefore, it would be sufficient to start with all the simple ideas, which are shared by everyone, and then develop them by means of an intuitive symbolic system. Thjose languages that are consciously produced by man through ad hoc *symbolic systems are referred to as artificial languages. The idea underlying the formulation of this type of non-natural language is the possibility to finally speak a common language; whether this may lead to smooth out disagreements, to eradicate hatred, or to enhance the economy is not that important from the standpoint of design. The crucial point is that, regardless of the language we employ or the part of the world which we find ourselves in, our natural language will however be characterized by several, often unsolvable, ambiguities. The beauty of a formal language precisely lies in the clarity of expression and the system's innate ability to equivalently produce, in principle, any possible idea. Language is in all respects a code, a means to express and communicate any given concept. Therefore, it comes as no surprise that anyone who had ever dealt with the task of devising a universal language had immeadiately focused on a process of modification and simplification of the code so as to make it practicable for the highest number of peoples possible.* The mystical-religious environment has been the best-suited context for the development of these particular languages. The birth of one of the first true artificial languages dates back to around the sixteenth century within the sphere of the Hurufi sect, namely the Balaibalan language, a sacred idiom that was based on a syntactic construction close to that of Arabic. Later on, in a letter to father Mersenne in 1629, René Descartes formulated the hypothesis of a universal language founded on principles of simplicity, characterized by regular conjugations and declensions and with no exceptions. Subsequently, he specified that a true universal language could simply be a philosophical language, i.e. a language where the forms of words and symbols

would reflect the universal order of human thoughts. Around the year 1670, Jan Amos Komenský developed the outline of an artificial language that was aimed at unifying and enhancing the characteristic features of several natural languages. The ultimate goal was to save the human spirit from the chaos of contemporary world thereby elevating it to its full potential. The year 1661 saw the publication of the "Ars signorum", where George Dalgarno, presented a "logical" system according to which the formation of words starts from the primitive meanings that constitute such words, with the aim of allowing men of different languages to communicate as well as enabling young puplis to learn logical-philosophical doctrines more easily than it was possible by means of the writings in the vernacular. In his "De arte combinatoria", which was published in 1666, Gottfried Leibniz dealt with the possibility of constructing a universal grammar aiming at setting the rules for the precise combination of words.Leibniz realized that there must be a form necessary to perform deductions: in fact, all the propositions may be reduced to a small number of primitive and undefinable propositions. The thorough enumeration of these primitive proposition (i.e. the alphabet of human thoughts) and their combination by means of a proper calculation would allow us to build all the complex propositions of thought. This would make it difficult to incur in the typical mistakes of discursive reasoning. The alphabet of the universal language should be composed of signs as they are indisputably able to both shorten the calculation and to convey ideas that cannot be represented directly. Furthermore, Leibniz was the first who conducted a rigorous assessment of the signs to be included into his project. At first, he seemed inclined to favour an ideographic kind of approach: these signs appear as able to speak to the eyes and be recognizable by all peoples (a reflection on the sign is sufficient to know the object). At a later stage, Leibniz became aware of the necessity for signs to exclusively correspond to calculus, rather than to things and concepts, inasmuch as that was the correct method to unveil the relationships between things and concepts. This is why the choice fell on an algebraic-mathematical system that was deemed to be the most appropriate system to the art of reasoning. Prime numbers hould have had to be the key elements of this system in consideration of they ability to "mingle" while preserving their original identity. Since the late Nineteenth century there have been advanced several projects concerning what are referred to as "auxiliary international languages", namely languages that are intended to spread across the world and be learnt by people of all nationalities. The German Catholic priest Johann Martin Schleyer invented the volapük, while in between

1872 and 1887, the Polish ophthalmologist Lejzer Ludovik Zamenhof gave rise to Esperanto ("one who hopes"), which was bound to become the most widely spoken artificial language thanks to the simplicity, cleverness and regularity of its grammar. Zamenhof's idea was rooted in his own experience, in particular the everyday problems he had encountered due to the language barriers within the communities. Despite the consistent efforts and the ingenious inventions of these remarkable figures, the artificial languages have failed to acquire the wide social recognition which their creators had hoped for. This is partly due to the fact that only few persons are able, not only to conceive, but to actually grasp the momentous significance of such an invention (most people don't even take into consideration the idea of studying a language of this type, nor they evaluate all the positive implications). On the other hand, to embrace a common language would partially mean to accept the fact that the nuances characterizing our native languages would be lost. The most serious concerns may lie in the fear of losing our own individuality, thereby getting trapped in the cage of uniformity of thought.

[114]Gottfried Leibniz 's idea is still fascinating from a computational standpoint and, in its essential acceptation, it underlies the current encryption systems (and therefore, the whole e-commerce system, credit cards and military security systems). Suppose we assign the concept of "woman" to the number 7 and the concept of "beautiful" to the number 13. Hence, the number 91 (= 7 x 13) will unambiguously represent the concept of "beautiful woman", there are no ambiguities because 91 is the product of two primes and the product of two primes is unique. If we assign the concept of "adolescent" to the number 97, then the number 8827 (= 91 x 97) will mean "beautiful adolescent woman", and so on with no theoretical limits with respect to any qualifying or poetical nuances.

[115] "I-ese". I-ese is the language by means of which the artificial-Selves developed in our research laboratory communicate and it is aimed at expressing the semantic essence of concepts in an unambiguous fashion while trying to preserve all possible shades of meaning. Not only i-ese is expected to allow an efficient transfer of knowledge to machines, but it should also become a useful communication tool between people. It is a simple language, which is constantly in progress, and which is based on very few syntactical and grammatical rules and is easily translatable into any other existing languages. Conversely, the same

process in the opposite direction (i.e. translation into i-ese) still requires much work.

[116]The main advantage of each of the languages we took into consideration was that they have been studied from a semantic perspective by generations of scholars. In particular, Sanskrit and hieroglyphic Hebrew are characterized by a marked "cosmological" component that is very close to our approach. In a sense, they are "religious-mathematical" languages, if not due to their origin, then because of all the subsequent elaborations they have undergone (for example, those of the Buddhist school with respect to Sanskrit and of the cabalistic school with respect to hieroglyphic Hebrew).

[117] This note has no title... *Self-reference is one of the most curious and captivating oheno-mena that can be observed within languages (of any type).Not only is it staggering to look at in the works of* Maurits Cornelis Escher, surprising to read in the works of Italo Calvino and Jorge Luis Borges, but this phenomenon is lso at the core of a series of logical-semantic puzzles concerning philosophy and mathematical logic. Beyond memorable plays on words (such as "I've heard that this sentence is a rumour…" by Douglas Hofstadter), the mechanism of self-reference is as common as it disquieting: if a proposition such as "this sentence has five words" is both sensible and intuitively true, a structurally similar statement such as "this sentence is false" seems equally unproblematic only at first glance. Let us ask ourselves whether such statement, which is also known as the Liar Paradox, is true or false: if it is true, then it truthfully asserts that it is false, therefore it is false! If it is false, then it is not true that it is false as it claims to be, hence it is true! Thus, we are led to the paradoxical result that the proposition is true if it is false and it is false if it is true.The first decades of the Twentieth century witnessed the beginning of the investigations of artificial languages and the development of a semantic approach to logic, then it became necessary to identify an effective strategy to escape these contradictions that so easily stem from self-reference within natural language. Alfred Tarski, namely the first logician to provide a definition of the truth predicate for a formal language, began his work with his famous Convention T, i.e. the bicondtitional that a given predicate T should satisfy to qualify as truth predicate: "<<t>> is T if and only if t", where <<t>> denoted the predicate on the right of the biconditional. To put it in simple terms, Tarski's Convention T is just a formal way to express the intuitively basic fact that if T is to mean "true", then the following must

hold: "snow is white" is T if and only if snow is actually white, "dogs are mammals" is T if and only if dogs are actually mammals, and so on for every proposition. Unfortunately, once we have defined a language L and convention T to regulate the operation of truth within L, the paradox is nevertheless lurking: in fact, Tarski proved that if the language L is sufficietly rich to allow us to speak of its semantics, then paradoxical statements such as the Liar paradox can be generated The moral he drew from this analysis was that, inasmuch as convention T is virtually inaccessible, then the truth predicate of a language L cannot be expresed within L itself. This line of thought led to the distinction between object-language and meta-language, together with the Tarskian prescription of defining the truth of the former by means of the latter. This solution to the semantic paradoxes closely resembles the type of solution which is most commonly resorted to for the paradoxes of set theory: Tarski's hierarchy of languages is the counterpart of Bertrand Russell's hierarchy of types (or that of modern set theories); in fact, given a language L and its meta-language M, it is fairly straightforward to realize that a new language N will be necessary to define truth within M, and so on. Two basic approaches have been proposed to solve the Liar Patadox. The first consists in discarding the principle of bivalence, according to which any predicate can take only two truth values, namely true or false. The introduction of a gap, namely including sentences thar are neither true nor false, coupled with a proper construction prevents the proposition "this sentence is false" from being both true and false. Leaving aside any judgment of the arguments used to support this startegy, the most serious problem of this approach lies in its being non-generalizable; if it is true that the Liar Paradox is no longer a problem, it is equivalently true that any slight modification to it becomes so. In fact, if we consider the statement "this sentence is false or neither true nor false", it is uncomplicated to verify that we are again in contradiction. The second approach to the Paradox is even less orthodox and it consists in accepting it as such. For now more than twenty years, the logician and dialetheist philosopher Graham Priest has been defending the idea that the appearance of a contradiction in our semantics should be taken seriously, at least when there are no ad hoc reasons for thinking otherwise. Therefore, the moral drawn by Priest is different from that of Tarski and the supporters of the gap theory: it only suffices to keep the contradictions and manipulate them by means of an adequate logic. Obviously, the clarification of the concept of self-reference as well as its role in semantic and logical paradoxes is of immeasurable importance. From our standpoint, it should be noted that the actual paradox involved in the Liar proposition does not emerge immediately and independently from a given context. Speaking in by-now familiar terms, this is encoded by the fact that the statement "this sentence is false" appears as problematic only if such statement is read through certain models of reference which not everyone, in all circumstances automatically resort to. From a cognitive point of view, it becomes easy to realize that the paradox arises only once our models have interpreted "this" in a self-referential sense and thus assigned "false" its strictly logical value. This is why, at a purely logical level, the Liar is problematic, nevertheless this does not imply that it is to represent an insuperable obstacle to knowledge or the modelling of the mind: in strictly logical contexts, solutions such as the Tarskian one become operable without any serious objections; in less rigid contexts, the use of different and more flexible models of reference allows us to disambiguate the situation and preventing the paradox from arising. The moral is that if there is a remaining problem with the Liar Paradox, that is a semantic problem which is generated by models of reference of a certain nature and which can be solved within that particular domain. On the oner hand, a thorough knowledge of the boundaries within which self-reference can operate without producing contradictions is obviously a fundamental prerequisite for a sound computational study of the most outstanding machine we know of, namely the human mind. On the other hand, and in part for the reasons we have just outlined, research at the cognitive level does not necessarily have to wait for the solution to the semantic problem in all its generality: as far as both the reproduction and the analysis of several portions of cognition are concerned, the tools and devices that have been developed are sufficient to set the problem. Relying on the models of reference as the "basic units of thought", our approach is clearly well-suited for (at least) commencing to tackle the problem in a functionally efficient manner. Forasmuch as part of our consciousness activity undoubtedly consists of the ongoing observation of ourselves (here the self-reference!), then the hierarchy of the models of reference can certainly be an extremely fruitful approach (as well as likely to be recursively generalizable). Furthermore, it should be borne in mind that, at a certain point, every adequate simulation will have to be able to handle the paradoxes stemming from our inconsistent beliefs in a mostly unconscious manner and on a continuous basis.

[118] Achilles and the tortoise. Zeno is undoubtedly one of the most fascinating minds of the pre-Socratic period: the form of refutation called reductio ad

absurdum can be plausibly regarded as an invention of his; his paradoxes continue to amaze and divide philosophers and scholars. Let us begin by considering a plausible imaginary scenario: Achilles, i.e. the powerful Greek demigod, decides to run a 100-meter footrace against the Tortoise, i.e. the ultra-slow land animal. In consideration of the clear disadvantage of the animal, the magnanimous hero allows the tortoise to start 1 meter ahead of him. Everything is ready for the start: what will happen right afterwards? Through the eyes of common sense, the fate of the race seems already sealed: it will take Achilles few seconds to catch up, surpass the Turtoise and smoothly progress towards the conclusion of the easiest among his legendary feats. It is here that the genius of Zeno came to insinuate the doubt: as a follower of Parmenides, he had grown accustomed to the idea that our everyday perception of reality is largely fallacious (the famous realm of doxa). Contrary to appearances, it is impossible for Achilles to reach the Tortoise! In fact, he would have to cover the one-meter distance initially separating them; however, during this time, also the Tortoise will have advanced to 1 meter+n centimeters from the start. At this point, Achilles should cover the gap between 1 meter and 1 meter+n centimeters, but, obviously, by that time, also his contestant will have advanced, thereby arriving at 1 meter+n+m centimeters from the start; then, the unfortunate Achilles should exert an additional effort to reach the Tortoise at 1 meter+n+m centimeters, but, by the same token as before, both catching up and surpassing the Tortoise are again impossible. Here is the promised result: no matter how fast Achilles may run or how slow the Turtoise may progress, there is no way to reconcile the logic of the paradox with our intuitive idea of motion. Thus, Zeno concluded that our naive theory is to be discarded just as any other doxa resulting from the deceptive appearances of the material world. The Achilles paradox is, so to speak, a variation of a theme which Zeno held particularly dear, namely the infinite series: a man will never be able to travel from one city A to another city B because first he would have to cover half the distance between A and B; on the other hand, he could never arrive at the midpoint since first he would have to cover a quarter of the distance, he could never arrive at a quarter of the motion because fiirst he would have to cover one eighth of the distance, and so on ad infinitum. If space is infinitely divisible, then it is impossible to move from one point to another. In the "standard" approach tpo Zeno's paradoxes, there are two main lines of arguments: on the one hand, it is claimed that modern mathematics has fully comprehended the behaviour of the series involved in the arguments against motion; on the other hand, it is asserted that the nature of the physical world is such that it can be accurately described by that same mathematics which is able work out the paradoxes. To proceed in an orderly fashion, the first consideration that should be made is that many (if not all) of Zeno's arguments, if seen through the eyes of modern mathematics, are subject to a significant reduction in terms of their paradoxicality. For example, relying on the work of Augustin Louis Cauchy on infinite series, it is possible to refute the natural conclusion that may be drawn by noting that any motion implies an infinite sum of subsequent motions (1/2 of the distance between the starting point and the goal, then 1/4, then 1/8 etc...): in fact, this infinite sum yields a finite result (1)! The second consideration that should be made is that even a satisfactory mathematical treatment cannot eliminate all the paradoxicality of Zeno's brilliant examples; in fact, if the world did not comply with the laws of the continuum and the infinite sums, then mathematical tools would not be able to provide any soundness to motion as it occurs in the physical world. This is why, besides relying on "deflationistc" mathematical stratagems towards the paradox, the "standard" approach must also claim the use of such instruments for the correct (and not merely useful) description of the real physical space. Nevertheless, it is clear that we have no a priori guarantee concerning the truthfulness of this assumption, on the other hand, not all the scientific theories seem to need it. A different approach may however be feasible: regardless of our belief that space is ultimately discrete (and that "motion" is actually a superficial phenomenon of reality), it may be useful to observe how the paradox arises by means of the models of reference. From an initial interpretation, the situation of Achilles and the Tortoise is nor paradoxical; essentially, this is the common sense conclusion which our first reasoning had led us to: the motion of bodies in space correspond to the (everyday and obvious) fact that things are in different places at different times and that some of them, in the same time span, cover a longer distance than others. The conceptual problems arise as the concept of "infinity" enters this picture ince it is triggered by the suggestion of the infinite divisibility of space. This creates a tension between the first conceptual level, which is interpreted through the models peculiar to perception (and thus to concepts such as "discrete" and "finite") and the second one, which has been surreptitiouly introduced by means of logic and which is interpreted through models related to "infinity". Moreover, it is fairly straightforward to realize that the reasoning cannot proceed on only one o the two levels, rather, once both of them have been introduced, it strives to make them coexist in a coherent manne, thereby failing: this natural carrying finity-related concepts to infinity and vice versa seems to be exactly what gives rise to the illusion of space as mathematically and physically impassable. In contrast, the preservation of a clear distinction between the planes allows us, on the one hand, to effectively maintain a coherent and cognitively satisfactory conception of motion, on the other, to recognize that, in pure mathematics (which – as we often repeat – once dropped into the physical world, is only a useful approximation) there exist several perfectly legitimate ways to reason within the domain of the infinite series.

[119] Axiomatic structure. Three hundred years before the birth of Christ, a Greek mathematician set a standard for all deductive sciences which was bound to exercise its influence throughout the millennia. In fact, Euclid's "Elements" was the first and most renowned logical systematization of the body of mathematical knowledge possessed by a civilization. The fundamental idea is simple: first, the terms used are defined; then, there is the introduction of a series of general geometric/algebraic concepts which are held to be true by definition, beyond any suspicion, i.e. the axiom (or postulates). Finally, we use only these principles as given to demonstrate step by step all the particular truths (i.e. the theorems) of the discipline. Inasmuch as it relies on the deduction of new propositions from other certain propositions, this procedure of knowledge acquisition guarantees the correctness of our conclusions; both the clarity and the semi-formal development of the demonstrations allow the logical relationships between even very different propositions to emerge. After being the model of eternal and indubitable knowledge for centuries, the "classical" Euclidean model fell into crisis with the discovery that the negation of an axiom (the fifth one, namely the axiom of parallel lines) allows the construction of other perfectly consistent (i.e. non-contradictory) geometric systems (with the related theorems). Non-Euclidean geometries provide the opportunity to address the problem underlying any axiomatic system (namely, virtually any formal and informal language): how can we justify the truth of the axioms? Does it make any sense to speak of the truth or falsity of propositions that are by definition unprovable? The development of mathematics and the discovery that many of its branches may be subject to different, yet equivalent, axiomatizations seem to undermine the aura of "absolute truth" which had come to surround the axioms over time. Rather than speaking of supreme principles, or self-evident propositions, in a simpler and more general manner, we can consider an axiomatic structure as any way to reduce a given set of knowledge

to a few basic principles and to everything that may be logically deducted from such principles. In a sense, this framework ends up turning the burden of proof of the truth of the axioms on particular propositions: some facts are so certain (or, more precisely, "efficient with respect to the description of the real") to be able to ensure the truth of the axioms which they may be reduced to. In other words, the act of faith implicit in any postulate can be justified by the usefulness and fruitfulness of the ideas and the research projects which stem from it.

[120] In a sense, we may consider the Prelude as a synthesis of all the books we have read and, even if we were to reason in terms of direct influence, it would be far from a simple task to make a satisfactory selection. Therefore, among the books related to the Prelude, we have decided to mention the first twenty that popped to our mind, including ten generally "famous" works and ten ones which are typically "unknown" to most people, without a clear logic or a precise order. Just pure brain storming. We hope this choice may be a sitimulating reference for people who are interested in the subject.
Uncertain author, *BarDo ThosGrol*
Uncertain author, *Bibbia - Libro della Genesi*
Uncertain author, *MahaSatipatthanaSuttanta*
Uncertain author, *Rig Veda*
Uncertain author, *Srimad Bhagavatam*
Uncertain author, *Tao Te Ching*
Abbott Edwin, *Flatland*
Asimov Isaac, *Chronology of Science and Discovery*
Blavatsky Helena, *Isis Unveiled*
Bohm David, *Wholeness and the Implicate Order*
Borges Jorge Luis, *El Aleph*
Einstein Albert, *The World As I See It*
Gershenfeld Neil, *When Things Start to Think*
John of Zebedee, *Apocalypse*
Kaiser Hans, *Lehrbuch der Harmonik*
Morris Desmond, *The Naked Ape*
Nietzsche Friedrich, *Thus Spoke Zarathustra*
Shuré Edouard, *I The Great Initiates*
Sibaldi Igor, *The Creation of the Universe*
Tsunetomo Yamamoto, *Hagakure*

[121] Georges Lemaitre was the first who advanced the theory that the universe had originated from th explosion of a "primeval atom"; later on, in 1926, Edwin Hubble focused on the study of a few particular stars exhibiting a variable brightness, i.e. the Cepheids. This specific feature enabled Hubble to recognize these stars at great distances and compare their observed brightness with their known luminosity, thereby allowing him to compute the distance to the stars from Earth. When Hubble compared the distance of the Cephelids to their velocities, he realized that galaxies are moving away from us at speeds proportional to their distances. Thenceforth, the most popular theory on the formation of the universe became Alexander Friedmann's 1929 theory: the theory of the "expanding universe". Building on the Hubble constant and the basic principles of Einstein's relativity, Friedmann observed that removing the cosmological constant from the equations would show the universe to be subject to an expansion motion, and characterized by a curvature that decreases with time as a consequence of the "dilution" of matter within it. Actually, it might not be the galaxies to move away, but, rather, it would be space itself to expand, dragging all the objects it contains. The initial explosion that supposedly gave rise to our universe and the space-time as we conceive it today is referred to as Big Bang. Obviously, we are still far from having reliable information regarding the dating of this event. The latest fairly convincing estimate has been made by some astronomers at the Carnegie Institution of Washington, they have compared the intrinsic luminosity and observed brightness of a pair of stars of the galaxy M33 in the constellation of Triangulum: these observations led to conclude that the universe is about 15,8 billion years old.

[122] Rivers of ink have been spilled in the effort of identifying a solution to the problem of the origin of life on Earth, as well as trying to establish the exact date of the transition from the anthropomorphic apes to the human race. What we know with some degree of certainty is that, as evidenced by several findings in Greenland, the first traces of organic matter made their appearance at some point abount 3,8 billion years ago. Geologically speaking, it all seems to have happened in a very short time; about 120 million years have elapsed from the time the Earth had reached some sort of balance to the moment life was born on the planet. It is clear that the elementary constituents able to ignite the spark of life must have been already present: the Earth's crust consolidated and cooled the atmosphere was filled with gases necessary for life and a real water cycle began to take shape. As the compounds of the atmosphere were carried

by the rains into the sea, there arised the reaction of lightnings resulting in large increases of energy; the action of the UV rays of the sun coupled with the activity of radioactive materials led to the transition from inorganic matter to the first complex molecules (traces of amino acids, namely the basic building blocks of the proteins that form the basis of any life form, have been found in interstellar gas clouds, in comet showers and even in billion-year-old meteorites). Even if there was sunstantial agreement on this point, it would still be problematic to identify the precise demarcation of the origin of life. In fact, the simple formation of organic molecules does not seem to deliver an impartial account of the events: these molecules must arrange themselves into more complex structures that are capable of self-reproducing, albeit in a still very primitive manner, before they may qualify as "life". If we were to reject the theory that life was carried by the interstellar mateerial, then we would be left with two possible alternative paths. The first approach maintains that everything has originated from short RNA sequences able to reproduce exponentially. Subsequently, after combining with enzymes that were already present, the RNA sequences colonized the lipid molecules, namely fat substances that tend to spontaneously form membranes: here there arose the first unicellular organisms. Nevertheless, this theory exhibits a few significant problems: first, a very high number of RNA sequences would be required in order for these reactions to occur, which would have been quite a miracle given the initial conditions of the "primordial soup". The second problem resides in the fact that the nucleic acid chains are extremely delicate and prone to an immediate decomposition when dispersed in the environment. The second theory draws its inspiration from the pioneering works of Alexander Oparin in the Thirties, and it asserts that the whole process was initiated by the lipids that, through the incorporation of the surrounding molecules immersed in water, led to the formation of non-uniform aggregates. It is very likely that a few of these aggregates have spontaneously developed some particular properties enabling them, first, to grow and then to replicate: after reaching a critical size, these aggregates have split, thereby generating copies of themselves, despite the absence of a real genetic system. Later on, the most successful protocells began to replicate faster and more effectively, giving rise to a sort of molecular spcialization which culminated in the creation of short sequences of information very similar to those found today within our RNA.

[123]Notwithstanding the enormous progress made in recent years, we only have a

vague knowledge of the functionalities of DNA. It is an extremely complicated task to set an, albeit approximate, date for the appearance of man on Earth. In addition to the typical problems with dating and examining the findings, there intervenes also a semantic component: what do we mean by "man"? As far as the evolutionary process is concerned, what are the elements that we deem necessary to unambiguously distinguish him from the other species? A fairly common approach points at the appearance of language. Nevertheless, today we know that also the other primates can "speak", though without matching our linguistic complexity. Other accepted approaches instead refer to the use of "tools" or the production of "artifacts". While we know with certainty that other primates also employ tools, the production of artifacts seems to be a peculiarity of man (provided, of course, that we do not overly extend the notion of artifact). From an evolutionary standpoint, we may define man as a primate capable of producing machines. According to this approach, the materialization of the first artifact should coincide with the appearance of man on Earth. On the basis of currently available information, it is reasonable to set an upper limit of around two hundred thousand years ago; conversely, it is difficult to establish a lower boundary, although the opinion of several researchers tends to converge on a value of about a million years ago. Today, it is really hard to say anything more on this matter.

[124] The world has always, and quite understandably, been looked at from a markedly anthropocentric perspective. The actual and fundamental reason lies in the fact that, as far as we know, we humans are the only living creatures who ponder on the why of things in the attempt to unveil the mysteries of reality. For thousands of years, man had considered himself to be at the center of the universe, or however the sole "beneficiary" of the existing reality that had been specifically created and developed for him. Today, it is legitimate to have some doubts. For instance, the role of "masters of the Earth" may be claimed by bacteria and viruses inasmuch as they have been on the planet longer than us and thus have proved more resistant to natural selection. For this reason and others of a more philosophical nature, there arose a few approaches alternative to the purely anthropocentric one. Among these, a very particular one is that developed by the environmentalist researcher James Lovelock. Lovelock was the first to conceive the Earth as a superorganism that is higher in dignity than its content: all earthly organisms coexist and interact in a sort of network that is aimed at preserving balance on the planet and the conditions for life. This

complex system of self-regulation is referred to as Gaia wherein the individual organisms would merely be temporary formations of interchangeable energy. We find echoes of this view of the whole also in the sphere of art. Godfrey Reggio created a sort of documentary in the form of a film, namely "Koyaanisqatsi". The title derives from "Ko-Yaa-Nis-Katsi", which is a Hopi Indian expression that means "life out of balance". The main character of the movie is precisely the balance of Mother Nature, while the antagonist is man's harmful effect on Earth and the central theme is the degeneration with respect to the primitive order. In contrast, there are also those who have proposed an alternative view of anthropocentrism, in complete opposition to the idea underlying Gaia. The main theorist of this approach is Richard Dawkins and its reference book is "The Selfish Gene". According to this particular view, the universe is composed of stable patterns of atoms and among them there are replicator molecules whose birth is completely random. The replicators that survived over time are termed genes: they are units that survive by passing from one organism to another and, to this aim, they have constructed "survival vehicles": from this perspective, we humans are mere survival machines for the genes. Inasmuch as the true and only goal of the gene is to replicate itself without taking any action that would increase the chances of replication for the other genes at the expense of its own possibilities, the adjective that more accurately describes it is "selfish". It is straightforward to realize how this approach completely reverses the perspective on the question: it is no longer the individual who needs DNA to exist; rather, the individual is an indispensable tool for the reproduction and the dissemination of genes.

12. The Systems

The concept of *System* basically encompasses the notion of elements that are connected to each other.

The biggest *System* that exists (and which we can talk about) is our universe. The smallest *System* depends on what representation model of reality is adopted (the quarks, the elementary cells, waves, etc...). In our case it will be the rhombic-dodecahedron shaped elementary cells with a diameter equal (or lower) than the Planck's length (~1.61×10^{-35} mt).

At present, we have no information enabling us to consider universes other than ours or the possible universe of the originative intelligences. Perhaps, as we move closer to the Solution to the Game, we will be able to construct some reliable hypotheses concerning possible systems existing outside our universe. For the time being, we must content ourselves with a few, fragile backward projection performed by our analogical mind.

Within our universe, a *System* can therefore be defined as any aggregate of contiguous cells. If the contiguity property were not maintained, we would lose the potential informational link and thus any form of connection[125].

Depending on how a *System* is looked at, we will have "internal" cells and "external" cells, namely cells belonging and not belonging to the *System*, respectively. Obviously, each cell can be a part of more than just one *System*.

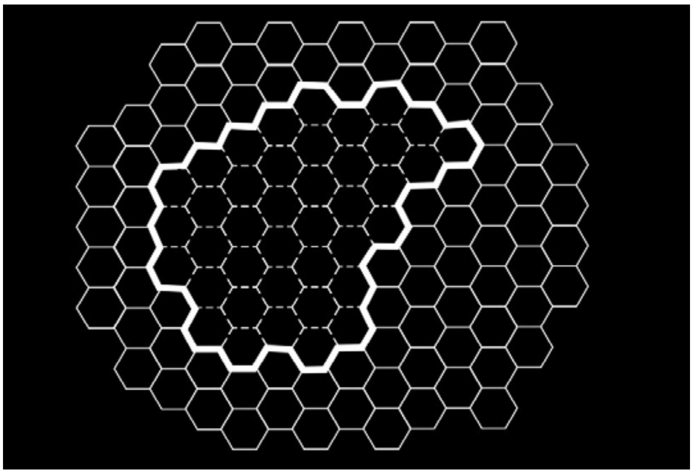

Fig. 12.1. Cells internal and external to a system in a two-dimensional universe.

If the modification in the state of an external cell is associated with the change in the state of an internal cell and vice versa (i.e. an alteration of the internal state corresponds to an alteration of the external state), then we shall say that the *System* "interacts with the environment".

A "perception" is an internal change that is caused by an external change. An "action" is an external modification that is triggered by an internal modification. A "thought" is an internal variation resulting from another internal variation. An "event" is an external alteration stemming from another external alteration. All this holds only with respect to the *System* under consideration.

When within a *System* that interacts with the environment there emerge thoughts (i.e. internal variations resulting from other internal variations), then we shall say that the *System* is "intelligent". The higher the ability of a *System* to internally change itself, the higher its degree of intelligence.

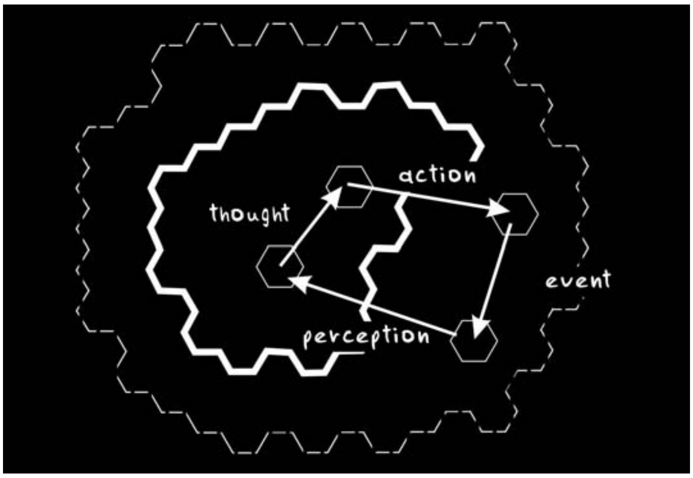

Fig. 12.2. “Perception”, “thought”, “action” and “event” with respect to the system being considered.

When an intelligent *System* is able to modify its own composition of elements, then we shall say that it is “living”.

A *System* does not exist in itself, but it exists only in our mind as a conventional and approximate aggregation of the manifestations of the real. Our inferences build on the concept of *System*.

Men are strongly influenced by the sense of sight and they tend to consider visual proximity as the main factor characterizing a *System*. It is this ground we have structured a substantial part of our thoughts on and derived our language from.

Fig. 12.3. A few innate concepts related to *Sytem*.

A cat is "cat" inasmuch as it is composed of external parts that move together and as it possesses the visual characteristics of "cattity", whatever that means. The cat hair left by a specific cat is no longer regarded as a part of that particular "system cat". And this can be corrected with respect to our model of universe.

By the same token, we generally tend to ignore the thoughts of a cat, its memory, what it has just swallowed into its stomach or the air it has just breathed. This approach, albeit efficient as a first approximation, is nevertheless a source of perceptual distortions and errors.

Under the perspective of semi-immortality, one of the chief mistakes that have being committed so far is that of viewing thoughts as separate from the body, that is to say, as not belonging to the same "system man". It is only a few years ago that we became aware of the relationships between lifestyles and diseases and of the relevance of the mental component in the healing processes. And it just couldn't be any different: man is a complex *System* that interacts with the environment and that is capable of self-modifying. This is the central tenet underlying our researches in the field of psychoneurophysiology.

12.1 The *System* Man

As we have just seen, from a systemic point of view, a human being can be defined as a complex system that interacts with the environment and that is capable of self-modifying. This seemingly simple definition holds a huge potential for any discipline whose object of study is to investigate the human being.

We are well aware of our ability of self-modification, but often we probably fail to examine it with due care. Let us begin from the most intuitive aspects. Through breathing we can affect the amount of oxygen in our body: as we all know, our system takes in oxygen from the environment. We can either let our breathing flow naturally or we can control its pace. If we learn to influence the way we breathe, we will be able to significantly alter the physiology of our body.

Let us discuss this further in detail. When we run our system automatically modifies breath frequency by adjusting the level of oxygen according to the body's requirements. This phenomenon is particularly noticeable at the end of a run. We are nevertheless able to control breath and to decide whether to accept the automatic variation. Furthermore, little practice may even enable us to modify also the automatic adjustment mechanism. Therefore, not only our system is able to adapt to changing circumstances, but it is also able to exercise a direct intervention in the adaptation process.

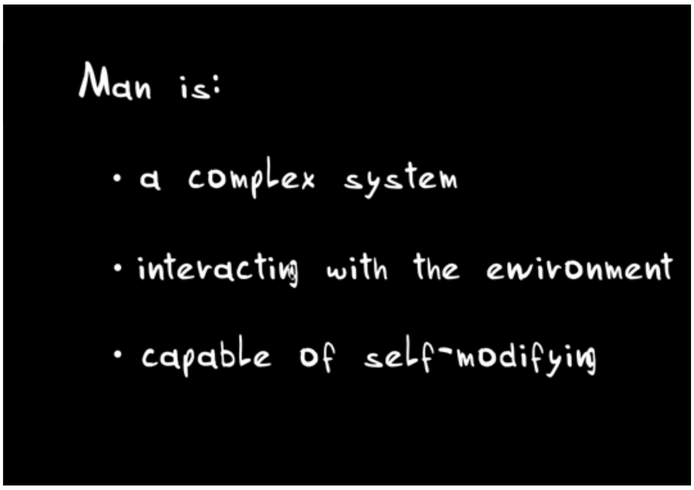

Fig. 12.4. The human being as a system.

All this is owed to the elevated self-referential ability of the system man. This fundamental mechanism allows the system man to try to better adapt to circumstances, to deal with unforeseen situations and to correct any possible system errors. In other words, we are self-referential (as we can alter our breath), recursive self-referential (as we can modify the alteration of breath) and meta-self-referential (as we can vary the laws governing the variation of breath).

Therefore, our life (as well as our death) is not only influenced by our DNA and the environment we live in, but it is also affected by our own ability of self-modification. The implications of this consideration are vast. Most mental disorders can be seen as errors in the process of self-modification. A phobia is an unjustified fear and, in its most severe forms, it is often accompanied by physical symptoms, which in turn influence and aggravate the psychic disorders. Patients suffering from leukemia are often prone to depression, depression in turn reduces the efficiency of the immune system and adversely affects the course of any disease. Today, it is difficult to question the importance of the patient's psychic state in relation to the processes of recovery. To stimulate the patient's self-referential mechanism means to operate on her process of self-modification.

Let us examine this from the standpoint of diseases.

• *Man is a complex system …*
This category encompasses the diseases of interaction, namely those illnesses we suffer from due to the attack of external agents. Such external agents may be real active agents such as viruses, or simply environmental factors such as pollution.

• … *that interacts with the environment …*
This category encompasses the diseases of interaction, namely those illnesses we suffer from due to the attack of external agents. Such external agents may be real active agents such as viruses, or simply environmental factors such as pollution.

• … *capable of self-modifying.*
Finally, we have the diseases of the process of self-modification. This category comprises all those pathologies of a psychological nature such as depressions, phobias, many forms of impotence and frigidity, etc...

This classification proves useful in providing a valid interpretation of the primary nature of the disease. In reality, in nearly every case, all the three factors interact in an interdependent manner. Thus, there will be a new aspect to be taken into account when examining any illness or state of unease. Besides the genetic and the environmental factors, we will have to consider also the mental factor.

From a theoretical point of view, we believe that the mental factor is more than just one component, albeit an important one, of the genetic factor. In our opinion, at this particular stage of research, it must be investigated using tools distinct from those employed to study the other two factors. Again, from the standpoint of research, we think that the mental factor also allows us to explain many of those phenomena that are difficult to understand in other ways such as, for instance, the so-called extraordinary healings related to religious beliefs, or the real functioning of the placebo effect and the relationships between lifestyles and diseases.

12.2 The arbitrariness of the concept of *System*

When we affirm that a *System* ndoes not exist in itself, but it exists only in our mind as a conventional and approximate aggregation of the manifestations of the real, we are implicitly stating that no *System* is higher in dignity than any other, and hence that there are no "a priori" systems.

What we are arguing is that within our universe any boundary is not intrinsically traceable, namely that any boundary is purely conventional. The very moment we draw the first boundary, from a logical point of view, we are led to a logical contradiction that cannot be resolved. Nevertheless, for the time being, the definition of boundaries is a sine qua non to the well-functioning of our mind and thus of us as human beings.

Here are our three minds at work, let us keep them distinct not to fall in contradiction. As far as the logical domain is concerned, ufortunately, the current state of knowledge does not allow a solution: boundaries are arbitrary, period. Within the analogical domain, boundaries are by definition dynamic and blurred. Inside the realizational domain, boundaries are essential to reason and therefore to the attempt to approach the Solution to the Game.

We therefore believe that what we denote as cat has no intrinsic characteristics of "cattity": "cattity" indeed is just a complex property resulting from the established habits and customs of our minds.

If the real can be described as the set of the elementary cells that make up our universe, then any aggregate of such cells, as long as they are contiguous, can be qualifiesd as a *System*. As we remarked earlier, an important consequence of this approach is that any given set of cells may simultaneously belong to a multiplicity of systems, each with its own rules and its own boundaries.

For example, the brain of an individual may be regarded as "brain in itself" but also as a part of a specific "system man". Within a room crowded with other people, it may be viewed as "one of the brains of the people standing in the room". But we may also consider it in relation to the "system building", the "system environment", rather than the "system Earth", or the "system Milky Way", etc…

Each of this system has sufficient dignity to be considered, if only because it is characterized by distinct, and often simultaneously interacting, rules.

The second crucial implication consists in the fact that the concept of *System* is rigorously applicable only applicabile only at a specific time "t". It is reasonable to expect that at time "t+1" the cells involved in the description of a given *System* will be different from those that were involved at time"t".

The second crucial implication consists in the fact that the concept of *System* is rigorously applicable only applicabile at a specific time "t". It is reasonable to expect that at time "t+1" the cells involved in the description of a given *System* will be different from those that were involved at time"t".

This point is clear if we consider our description of the universe as based on elementary cells, but it just as understandable if we take into account a more traditional description of reality resting on atoms and molecules. A few moments later, what we continue to call "that cat" will certainly be different if we describe it as molecular composition (air, food, metabolism, thoughts, etc…)[126].

12.3 The usefulness of the concept of *System*

Our mind bases its inferences on the concept of *System*. Therefore, its usefulness is immediately recognizable: without the derivations of such concept there would exist neither symbolic reasoning, nor language, nor this book, etc... In line with our approach, it must be pointed out that, whatever reasoning one wants to present and share, it is always necessary to first agree upon the various boundaries to trace. In other words, it is necessary to identify as accurately as possible the models of reference that contribute to the formation of every system (and therefore, to its definition).

This framework theoretically covers any problem that might arise. For instance, let us analyze a controversial issue such as that of abortion. Depending on how we define the "system man", we are consequently able to discern what behaviour is consistent with our models of reference and what is not.

We define homicide as the realized cessation of any system man. And, for the sake of simplicity, we always consider the act of committing a homicide as wrong. Depending on how we define the "system man", we will be able to identify under what conditions a certain action can be regarded as wrong. If we rely solely on the specificity of DNA to distinguish the system man, then the elimination of fetus any time after the formation of the first cell is undoubtedly murder. If we add the concept of information, then it become a murder right after the appearance of the first nerve cell. If we include the concept of sensation, then it becomes a murder right after the formation of the first pleasure/pain mechanism. If the system man acquires its specificity only after the separation from the mother's body, then it is not homicide until the actual birth[127].

The systemic approach allows us to regard this type of problems as complex but not unsolvable. It is sufficient that, first, they are inserted into a model that is as coherent as possible and well-formulated and, second, that all the foreseeable consequences are inferred and accepted.

We have shown that the arbitrariness of the concept of *System* not only does not prevent our mind from using it, but it even provides the basis for any reasoning. The systems can effectively be defined as the interpretative keys to reality. The fact that one key might work better than another leaves the concept of equal dignity unaffected[128]. It's only that any given key will be more or less useful for the description of the real. Up to the moment when it is in turn replaced or complemented with even more accurate and efficient keys. For instance, the conception of the system man as composed of multiple systems interconnected to each other has brought remarkable benefits to the understanding of reality and, consequently, to the treatment of diseases. In the earliest stages of human culture, man was exclusively considered as "external reality", thereby delegating the processes of disease and recovery to the influence of the various deities. Then, we began to conceive man also in relation to what directly "entered the body" (nutrition), starting to think about the existence of a genuine "internal" reality (organs, blood, humors). Therefore, we have embarked in the examination of the influences of the surrounding environment (ecology, chemical agents). Later, we have become aware of the existence of the "mind" (psychology) and of its effects on the body (psychoneurophysiology). Finally, we have discovered and accuratey identified those that might be defined as the basic instructions of what we tend to define as system man (genetics).

As explained in our methodological premise, attention should be paid to the dangers of overlapping domains: such dangers are magnified in the context of the arbitrariness of systems. When, from the standpoint of our logical mind, we argue that no system is higher in dignity than any other, and hence that all systems are arbitrary, the other two minds of ours will most probably find it hard to accept this notion. In all probabilities, the realizational mind will ask: "but if all systems are arbitrary, why should I be interested in achieving semi-immortality, if there is no form of preservation of my own identity why would I care about being immortal?" [129]. And the analogical mind will go: "what the hell of a game is this if the participants are only arbitrarily defined, who's winning then?". We surely have no definitive answers to these two questions. For the time being, the only answer we can give you (and ourselves) is the following: "for the moment, let us concern ourselves with attaining semi-immortality and then we will figure out what's next…".

Instead, the reflections on the possible existence of a "void system" and of nothingness (as well as the speculations about the existence of an "unlimited system" and of infinity) are solid examples of the risks related to the confusion of levels. At a primary physical level, in our universe it doesn't make any sense to speak of a null system. Very simply put, it just does not exist, it is not a part of the real. It exists just like a chimera does[130]. Therefore, it exists only at the level of the models of reference that are applied to the information content, it does not exist at the level of physical reality. If the physical space is composed of indivisible elementary cells, then a single cell will be equipped with at least one state, perhaps neutral (whatever that means). For instance, there cannot exist such a thing as a non-cell in the physical space. Whereas, in the space of the models of reference applied to the information content, the existence of a non-cell implies no particular problem (again, whatever that means). Much the same holds for infinity. We believe that a discrete universe is not compatible with the concept of infinity. Infinity is obviously an extremely useful model of reference developed by our culture in the space of information, but it does not exist in reality. From our point of view, the mathematics that makes use of the notion of infinity (and thus of limit, derivative and integral) is an inaccurate mathematics. We all employ it, and with great satisfaction and profit, nevertheless, as far as the description of reality is concerned, it is imprecise.

[125] Obviously, contiguity may also be established by the ability of a system to employ the laws of the physical universe, for instance through a link via electromagnetic waves (as in the case of two devices that can transmit and receive radio signals). Therefore, if we consider the famous literary-philosophical example of the brain which is placed in some room a thousand kilometers away from the body, but still connected to it via a sophisticated radio transceiver device, we will effectively be in presence of a single system, therefore the switching off of the transceiver device would isolate the brain from the body so that they could no longer be considered a single system in any respect. Nevertheless, from a conceptual standpoint, the problem is not fully solved. In fact, as the body is progressively moved away from the brain, there comes a point when, on the basis of our current physical knowledge, the two-way communication may no longer be regarded as "immediate". If the body is on a spacecraft near the Sun, then any signal will take a few minutes to reach the brain that is still on Earth (the Earth-Sun distance is about eight light minutes): from our point of view, we believe that the system may however be seen as a unique system as the communication channel enabling the flow of information would still be a part of it. If this reasoning is valid for the Sun, then it will be equivalently reliable for Alpha Centauri, i.e. the star about 4,3 light years away from the Earth, and so on, for increasingly greater distances. Generalizing our example, we can assert that if the delay in the informational transmission is irrelevant to the very existence of a system, then each part of our universe, as placed in the correct time scale, is in "communication" with any other part. Consistently with our view concerning the complete arbitrariness of systems, this means that, in practice, any possible configuration is a system, without offending the ordinary concept of identity.

[126] A world without objects. According to the approach of our research laboratory, the ultimate level of reality is modelled as a set of cells that represent the basic building blocks of the universe. When we state that there exist cats, pine trees, streets, people, cities, we are not referring to the existence of something irreducible and fundamental; conversely, we are speaking of particular sets of cells in a given state which we consider so important to deserve to be assigned a specific predicate in our language. This is why a system is any one set of contiguous cells in space-time; there is no difference of ontological status between any one system and another, rather there subsists only a a distinction in terms of

their cognitive relevance: several reasons, first evolutionary then cultural, led only some of the various possible *patterns* to be selected as salient system and captured by the conventions of language. At the very moment we trace boundary we seem to be put in an uncomfortable position: why is the line to be drawn here and not one cell away? By arguing that no system exists in itself, *ipso facto* we are able to discard these concerns; we are fully aware of the arbitrariness of our lines, but, inasmuch as we assign them a functional value, we do not have to logically justify them: they are how they are for the sake of our convenience, and this is the only possible justification. The particular distinctions that are chosen by our cognitive system, however useful to life they may be, do not have any metaphysical priority over other more extravagant ones: aren't pincats (i.e. those strange objects composed of pines and cats, which we never mention) legitimate portions of reality, in the fullest sense of the term? This approach to reality naturally applies to other philosophical questions, such as the theory of persistence: what does it cause a system at a time t to be identical to a system at a time t+1? The answer is that there is nothing able to act as such an "ontological glue": nothing remains literally identical to itself, there are only distinct portions of space-time whose qualitative similarities are so marked to our eyes that we are given the illusion of persistence. Throughout the history of thought, the debate about boundaries, identity and persistence has seen the crucial participation of the most prominent thinkers. Already in ancient Greece, there emerged opposite trends, as we realize by comparing Protagoras and Plato. It may suffice to juxtapose the well-known passage of the Phaedrus where Plato recommended to cut up the being along its natural joints, trying "not to splinter any part, as a bad butcher would do" and Protagoras'precept that "man is the measure of all things", namely the first real manifesto of cognitive realativism. The Aristotelian view was profoundly influential throughout ancient and medieval times: the basic idea is that the world is organized into a hierarchy of systems (i.e. substances), which are divided by genre; the essence of a system derives from the fundamental (namely, the most specific) genre it belongs to. Nevertheless, this metaphysical framework (which is marked by a sortal character) was already questioned by modern philosophy with the rise of British empiricism. John Locke and David Hume have revitalized classic debates bringing forth original solutions and new arguments: the former replaced substances with *bare particulars*, i.e. strange substrates carrying the properties we assign to objects, while the latter pushed himself further by arguing that objects are merely bundles of properties; the former subscribed to a theory of identity related to sortals and he maintained that distinct things can occupy the same place (as long as they belong to different sortals), whereas the latter was an obstinate supporter of identity *simpliciter* as well as the purely fictitious status of our attributions of diachronic identity. Contemporary philosophy has been vivaciously discussing the problem of the nature and persistence of systems. The openly neo-Aristotelian position, best exemplified by David Wiggins,, is contrasted by revised versions of bundle theories (which were proposed, for instance, by Bertrand Russell). More recently (along lines already present in the works of Willard Quine and David Lewis), a markedly conventionalist view of the objects populating our ontology has being decidedly advanced: "reality – as argued by Achille Varzi – would ultimately consist of pure and simple four-dimensional matter extended in space as well as in time, and to speak of objects is equivalent to speak of specific portions of such matter. What portions? Any to one's liking". This last position is on the same wavelength of the latest "neo-Humean" theories of persistence (stage *view theory*): Theodore Sider rejects the view that objects remain identical to themselvs throughout time; each individual thing lives only for one instant, but it is spatio-temporally contiguous and qualitatively similar to many other things, this is why we are deceived about persistence. Literally speaking, when we talk about our own childhood, we are not referring to ourselves, but rather to parts of reality which are "related" to us. As it appears, we are brought back to our research laboratory's model of universe with its cells and its arbitrary systems.

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[127] *Abortion and ontology.* Every argument on the issue of abortion must be founded on a concept of person. The debate is generally divided into two camps: those who are in favour of abortion typically adopt a functionalist view of the concept of person (to be a person means to be actually capable of performing certain operations); on the other hand, those who oppose to abortion take a substantialist perspective (to be a person is to be a certain type of entity) within an essentially Aristotelian view, using the dualism between act and potency as the pivot of their argument. Let us start from the logical formulation in support of the illicitness of abortion: given that I) it is always gravely immoral to intentionally kill an innocent human being; and II) the fetus is an innocent human being; it follows that III) direct abortion is always gravely immoral. For the sake of clarity, let us try to give a more accurate definition of the words used in the syllogism. The adjective "innocent" implies the exclusion from the formulation of all the series of homicides that are traditioanlly justified inasmuch as they are committed against non-innocent individuals or persons who are subjectively guilty of a crime (self-defense, death penalty, killing in battle, etc...); the adverb "intentionally" rules out the killings of innocent human beings which occur as unintended consequences of an in itself legitimate act (for instance, the cases in which certain curative substances are administered to pregnant women at risk of death); finally, "direct" abortion denotes an abortion in which fetal death is intended as an end by the agent, or as a means to the pursued objective. Therefore, the attempt to morally justify abortion can follow two alternative paths. The first is to accept the logical validity of the traditional syllogism, but to attack the minor premise: the fetus is not an innocent human being; or, more precisely, there is a clear distinction between person and human being, the fetus falls into the second category, but only the first one is entitled to the right to life. The second strategy denies the validity of the implication between the premises and the conclusion: while it is true that the fetus is an innocent human being, it is not true that killing the fetus is always gravely immoral. There are cases in which killing a human being is permissible because the alternative available to the agent would involve excessive costs. What very few people think about is the fact that there exists a third approach to the purely ontological-metaphysical question concerning persons: persons are neither a kind of thing (in the sense of "ontologycal type", "sort of things"), nor anything that meets certain functional criteria. Literally speaking – this is the third way – persons do not exist independently and autonomously. We find it difficult to accept the idea that in the world there may be objective contours, independent

ontological boundaries. In other words, there is no way to determine with absolute certainty not only when a person begins to live, but even what a person truly is. When we talk, think, act , what we do is "to cut out" some portions of matter in the space-time rather than any other ones. The fact that we tend to focus on certain particular boundaries and figures does not imply that they have a privileged ontological status. The conventions that govern both our life and our language tell us what, under normal conditions, can pragmatically be defined as "person" and what cannot. Nevertheless, in some borderline situations (embryos, fetuses, intelligent robots, humans in a coma, etc...) we are given no incontrovertible indication of how to behave. And precisely in cases like these, where our insights fade and the issues become controversial, there arise many of our philosophical doubts concerning the conditions of identity (what criteria must x satisfy to be P?) and persistence (when is it that x at t1 e y at t2 are the same thing?) of the things surrounding us. Disagreements within this theory are explained by the uncertainty about what our words refer to, in fact, beyond a certain degree of precision, they inevitably become vague: we may artificially restrict the extension of a predicate, but it will be a *fiat,* predicate, a choice, and only one among the mant possible ones. The extreme difficulty in determining once for all what qualifies as "person" in every context springs from the fact that there plainly is no answer to such question; the "solutions" to many puzzles about identity are simply what they seem: arbitrary decisions – and supported by *ad hoc* justifications – concerning where to set boundaries. If we exclusively rely on the logical brain, the consequences of the arbtrarinesss of systems on an ethical level may bring about the risk of justifying any behaviour; we believe that this would lead to a limitless violence where the strongest system always prevails. This scenario might not be terribly upsetting to someone, but it must be borne in mind that no system can always be the strongest and, from the perspective of the Game, this is a contradiction. If we accept the ultimate consequence of the logical reasoning, then we also have to accept the ultimate implication of the ultimate consequence, namely limitless violence. At this point, we think there is something wrong. Luckily enough, the other two minds do their job and help us to overcome the unwanted consequences of purely logical reasoning. The analogical mind points in direction of the Game, thereby opening the way to ethics, truth, love and happiness. The realizational mind prompts us to avoid violence as much as possible inasmuch as it produces suffering and suffering generates death. As usual, our view is that no "serious" achievement is possible if only one mind is involved. The combination of the three minds still does not give us any absolute certainty, yet, in the meantime, we try to enjoy ourselves and those around us. And usually, abortion is not enjoyable, neither for the fetus, nor for the mother, nor for the father...nor for the Game.

[128] Induction and demarcation. The problems of induction and demarcation have been among the central issues of philosophy of mind throughout the Twentieth century. These questions may be plainly delineated as follows: the problem of demarcation is the identification of a criterion to distinguish between what can be defined as "science" and what is denoted as "pseudoscience"; the problem of induction is to logically justify the movement from individual observations to general laws. On second thought, human beings are utterly reckless: they climb on bridges that might crumble, they use elevators that might break down, they take far-off commitments when they may not live to those days, they leave alone their wives who may cheat on them and they believe in theories that may any time turn out to be incorrect. If you stopped a person on the street and asked him how can he be sure that tomorrow the sun will rise, that his wife is faithful to him, that gravity will pull him back to the ground after a jump, the answer that you are most likely to receive is that this is just how things have always gone, which is a good enough reason to believe that they will continue to do so. Some philosophers maintain that induction and demarcation coincide: it is only through the acceptance of the former that it becomes possible to distinguish science from myth, poetry and religion. Nevertheless, several philosophers have taken different approaches to the solution of these two problems. One influential proposal concerning the criterion of demarcation was advanced by the Vienna Circle: a theory is scientific if and only if its statements are verifiable, namely if they are observational statements or truth-functions of such statements. What does this implies? The truth of a simple observational proposition like "the ball on the carpet is red" can be established by direct observation; the truth of a compound proposition such as "the ball on the carpet in the room is red and the cat on the couch in the living room is black" entirely depends on the truth value of its constituent observational propositions. According to Karl Popper, the solution to one problem (demarcation) implies the dissolution of the other (induction). He agreed with the neo-positivists on the fact that only a finite number of events can be observed, yet empirical sciences usually formulate general statements and therefore they must apply to an unlimited number of events. Take the classic

statement “all ravens are black”. It is fairly straightforward to realize that this statement is not verifiable inasmuch as its verification would require an infinite number of observations, but it is undoubtedly falsifiable since it would be immediately falsified if one observed even one white raven. And the same argument applies to all universal generalizations. This is why verifiability cannot be the criterion of demarcation: theories are never empirically verifiable, but only falsifiable. Hence, the true criterion is falsifiability: a theory is scientific if and only if its propositions are falsifiable. Popper's solution to the problem of demarcation leads to the “dissolution” of the problem of induction: according to Popper, induction is never justified. A theory (deductively) implies an observation and, if such observation is false, then the theory is “disproven” and it must be replaced with a new “conjecture”. However, the dismissal of induction is not easy to implement or to accept: almost the totality of our life rests on the general assumption that things will keep going as they have always gone: at the end of the day, how many jumps do we need to be convinced that the law of gravity holds true? Ten, one hundred, one thousand? If there is no logical guarantee that the step from particular premises to universal conclusions preserves the truth, then what is it that justifies our most deeply rooted beliefs? Furthermore, there are substantial reasons to think that Popper's proposal is not even logically flawless: when it is argued that when an experiment does not falsify a conjecture it “corroborates” such conjecture, doesn't it imply that the theory is more likely to be true? And once our theory stands against one thousand attempts of falsification, aren't we allowed to believe more in this theory than one which is supported only by ten corroborations? As recognized by Imre Lakatos, the formulation in terms of “progressive approach to truth” which is given by scientific theories is clearly justified by inductive intuitions. On the other hand, this is less serious than philosophers usually think: there are moments in which we rely on intuitions, sensations, unorthodox methods, unjustified protocols, very long moments of healthy pragmatism (“it works then it is fine”), and these moments precede the time when we achieve a satisfactory and elegant systematization of our conceptual apparatus. The problems of induction and demarcation do not only concern black-plumed birds and dinner party conversations; to illustrate the problem, we will use a real case of scientific practice: a double-blind trial to test a new drug, let it be drug X. In our double-blind trial, the drug X is randomly administered to a group of patients, while the drug Y with no active ingredient is given to another group . The administration of the drugs is handled by a computer and before the end of the experiment neither the patients not the investigators are able to know who has taken the drug X and who has received the drug Y. If X has delivered better results than Y, then the effectiveness of X is proven. The double-blind method is a paradigmatic example of good science: first, a conjecture is formulated, then its prediction is verified; if the result is positive and, given that the test is designed to eliminate any kind of bias, then it is possible to justifiably conclude that the theory is correct, at least "until proven otherwise"; if the result is negative, then a theory that supports the effectiveness of X is not scientifically valid (not even under the exotic name of "alternative medicine"). This implies that henceforth we will use the drug X confiding that the effectiveness which has been proven in the trial will also be confirmed in real life; we have verified that starting from a scientific, that is falsifiable, theory it is possible toachieve a result which we will inductively employ in everyday life. Hence, it is now clear that induction and demarcation are two facets of the venture of knowledge: a mature science would be merely unthinkable without a rational and rigorous application of the teflections in these two domains.

[129] The problem of personal identity. The issue of personal identity is one of the most complex and, in many ways, fascinating philosophical problems. This question has been addressed by the various research fields and the answers they come up with are becoming less and less obvious with the advancement of biological and robotic knowledge. Let us begin by specifying the precise meaning of the term "personal identity": it refers to the criteria that allows us to speak of permanence of the person over time. The common-sense notion of personal identity often tends to identify an individual as the same entity on the basis of a purely bodily continuity. This is a sort of "empirical criterion" of personal identity and it clearly rests on the adage of "one body, one person". The problem with this principle is that it doesn't reach the philosophical core of the matter. In fact, it is easy to imagine cases in which the mental content of an individual is transferred to the body of another. Now, would this subject the same individual or a different individual? It is these type of problems that put the intuitive notion of personal identity into question. This series of "thought experiments" (whose initiator probably was John Locke) has been initiated by those who claim the superiority of a psychological criterion of personal identity with respect to the bodily criterion. In fact, these philosophers maintain that an individual's personal identity is determined by the continuity of consciousness. Among the first to rigorously deal with the problem of personal identity, René

Descartes argued that there is a fundamental distinction between the substances found in nature. Modifying and building on the existing body of knowledge on the topic, Descartes emphasized the difference between mind and body: the mind is defined as "res cogitans" (i.e. thinking thing), while the body is referred to as "res extensa" (i.e. what is extended in the physical space). This theory, basically asserts that the persistence of a person is related to the persistance of a certain type of substance, namely theres cogitans. Though many of his arguments are now considered outdated, or at least inconclusive, the huge import of his contribution should be pointed out, as it was René Descartes who started the climb to truth relying on the scientific method. John Locke instead was the first to maintain that both the identification and the meaning of personal identity depend on a psychological rather than empirical criterion. According to Locke, a person is an intelligent and thinking being, who is endowed with reason and reflection and who is able to conceive himself in different places and times thanks to awareness that is inseparable from thought Consciousness unifies our present sensations and perceptions and it can be extended backwards to past actions and thoughts. Therefore, the identity of a person stretches as far as so does the awareness that the Self which was acting in the past is the same Self which is now representing it in the reflection; it is the continuity of consciousness which creates personal identity. It is irrelevant whether it is the mind or the body that thinks. The substance no longer matters: if we consider the fact that one of the fundamental tenets of functionalism is the independence of the mental from the physical, we are able to appreciate the momentousness of Lockean thought. Locke was the first to identify the functional level as the context in which to place the problem of personal identity. David Hume took an even more radical position than Locke, arguing that we have no impression of a permanent, let alone unitary, ego. We are not able to identify ourselves as separated from perception; in a sense, that is all we recognize. Hence, we may define the self as a "republic of mental states", a bundle of perceptions, each of which having an existence of its own and independent from the substance that possesses it. Our convinction that we exist as entities that are continuous over time is illusory: persistence is a mere perception of the succession of perceptions. Therefore, identity is just a property that is assigned to perceptions and caused by the union of ideas in the imagination, as soon as we reflect upon them. After a quite meandering path on this matter, Bertrand Russell argued that a person is a typical case of logical construction: there is no material difference between me and a soccer ball. The Self loses any privileged ontological and epistemological status. Daniel Dennett drew on and extended the Humean idea of the illusory nature of the self. Within our brain, there is a more or less ordered aggregate of specialized brain circuits. They work together to produce a "virtual machine", the "Joycean machine",operating as if there were a pilot which actually is absent, i.e. the virtual captain. This virtual captain is the spokesperson for a series of alternating coalitions, and not the expression of an individual persisting over time. According to Dennett, the peculiarities of our species include our "secreting" a Self, a sort of center of narrative fravity, an abstraction that we are encouraged to create for purposes of social reliability and self-understanding.

[130] Does "nothingness" exist? One question – almost a sense of diqsuiet – has been repeatedly posed throughout the history of thought, in the most diverse minds and forms: Gottfried Leibniz wondered why there is something rather than "nothing", Ludwig Wittgenstein stated that the true mystery does not lie in what the world is like but rather in the fact that it exists. We do know that something exists, but this is not sufficient: alongside with Wittgenstein and Leibniz we are naturally driven to ask ourselves what is the underlying explanation to this fact, the ultimate reason of the existence of the world. As we have seen ever since the Prelude, our approach may provide an answer to such question, as speculative and analogical as it might be (can someone perhaps do any better than this?): something outside our world has created the Universe (perhaps with some other ones) and has given it its cells and its laws. This is why something exists. Both the being and the non-being exert an enormous fascination on us which may pull us into arguments that are as seductive as they are misleading. In fact, we must not yield to the temptation to jump from analogy to logic claiming to be dealing with the problem in a sensible manner. The fact that we have identified an analogical answer does not allow us to logically ask ourselves a question which is only superficially similar, namely "what is nothingness?". Those who attempt to take this step are bound to get lost in confused reasonings, precisely because there is a confusion of levels. Within our model of reality (which, as it should be borne in mind, falls within the scope of logic) the absurdity of seeking for nothingness becomes immediately clear: trying to identify a physical equivalent for the concept of void system is just a waste of time. In fact, if it is true that the Universe is a set of cells in certain states, then there is no way to have a non-cell. Using a metaphor, we may say that the universe is like a bottle of water: it may be empty, yet the

bottle still exists; by the same token, all cells may be in the neutral state (whatever that means), nevertheless the universe exists. In any sense, there is no space for nothingness: to quote David Lewis, "nothing is not a very minimal something". A similar confusion may also arise from other concepts, such as infinity. If we focus on the basic structure of our world, an infinite system loses any sense: there is no place for it in the discrete reality of our fundamental cells – this is an idea that goes back at least to Aristotle, who seems to have maintained that an infinity in act is impossible. All of the above of course does not mean that nothingness (or infinity) are unthinkable, just as it is not inconsistent with the existence and the usefulness of models of reference related to these concepts.. a moment's reflection is sufficient to realize the extensive use that mathematics makes of such notions, in particular the part of mathematics devoted to the description and prediction of the events in the physical world (which most often an area of interest and expertise of our mind's realizational part). The situation is not much distinct from the problem posed by the horse Pegasus or the chimera: while the real world has no place for these things, in our thoughts about the world, in our speeches, in our stories, in short, as information content, their existence is neither problematic nor controversial.

13. Ethics

The concept of *Ethics*, and thus of good and evil, basically enompasses the notion of objectives to be attained and of possible paths to achieve them. If an action takes us closer to the goal, then it is good, if it drives us away, then it is evil. It follows that being able to evaluate an action requires, first and foremost, an adequate knowledge of the objcetive. Two different goals might lead to consider the same action in two opposite ways. But if we agree upon the fact that the ultimate goal of our Game is the understanding of its rules, then it might perhaps be difficult, but not impossible, to try to hypothesize the paths. Therefore, it is witin this context that it is correct to speak of good and evil, and it is exclusively within this context that we will be proceeding.

What are the conditions that foster the understanding of the Rules? Of course, the answer is extremely complex and it cannot be addressed with some oversimplification. By Rules we mean the whole spectrum of the laws and the elements that make up the reality of our universe. Until we do not possess a thorough knowledge of the Rules, we will only be able to reason in probabilistic terms. However, the more we refine our understanding of the Rules, the better we will be able to discard all the paths that are clearly inconsistent with them, besides, obviously, being able to formulate new ones.

With this chapter we get to the very heart of the philosophy of immortality. The two previous chapters bring about a load of implications, but they have only an indirect effect on our daily life. In the so-called Western world, it is virtually always possible to address them without triggering excessive emotional reactions in response. Most people are not that interested in whether the universe is discrete or continuous. They tend to take a slightly stronger interest in the arbitrariness of systems, nevertheless a certain degree of relativism is the common heritage of all not excessively dogmatic societies.. All manner of opinions might be agreed with or not, but generally the battleground is confined to the verbal sphere and it is however nearly always limited to small circles of people who deal with the topic. *Ethics* is a wholly different matter. Perhaps our current civilization doesn't get to the point of generating systematically violent behaviours, nonetheless the battleground is charged with emotional intensity. Husband and wife fight, suffer and split up if they fail to converge to the same shared values. Parents and children do not talk to each other. Contrasting opinions on issues such as abortion, drug use or sexual freedom can easily trigger irreconcilable conflicts and sometimes even result in the extreme reaction of depriving the other of life. This is because different opinions lead to different behaviours and we, justifiably in an evolutionary perspective, try to protect ourselves from others' unwanted behaviours.

Numerous thinkers have cleverly concerned themselves with this topic, from Confucius to Friedrich Nietzsche, and again Protagoras, Jesus of Nazareth and David Hume. We might even argue that philosophy was born not only to investigate the ultimate laws of the universe, but also to support us in understanding what is good and what is evil. It is not easy to keep the issues distinct. In the next paragraphs we will present a path that is formally consistent with all our premises, obviously, exclusively in the perspective of the Solution to the Game. In a sense, it might be described as a sort of *Ethics* of semi-immortality.

Fig. 13.1. A few innate concepts related to *Etihcs*.

13.1 Truth

The concept of Truth basically encompasses the notion of description of the real. Therefore, there exists the real and there exists our mind that observes and describes it. It is our conviction that Truth is the primary yardstick for discriminating between all the possible paths towards the Solution. If there exists one fundamental value from which all the others spring, then that is Truth. Truth is good, non-truth is evil, everything else is a consequence.

The real does exist, it is the physical world and the world of information we live in. Through the multiplicity of our senses, our mind is able to perceive it, represent it and describe it both to ourselves and to the others. We know that our senses are able to have only a limited and often mistaken perception of reality. This is one of the reasons that led us to construct machines. We are aware of the necessarily approximative nature of our representation of reality and of the fact that the language we use to describe it is often a source of ambiguity. This is why we have developed representation models based on mathematics and why we are investigating the nature of language. Nonetheless, these limitations do not prevent us from triying to distinguish a Truth from a non-truth. Truth is a correct description of the real, whereas non-truth is a misdescription[131].

If the Solution to the Game is the understanding of the laws and the elements that constitute our universe, then nothing is more imperative than providing its correct description. Hence, first and foremost Truth to ourselves and then Truth to the others. Forasmuch as our means of understanding and analysis are necessarily approximate, we will speak of tendency to Truth. Since Truth covers all the facets of the real, the more we shift from the domain of actions to the sphere of thoughts, the more difficulties we will experience and the more support we will receive from the concept of tendency.

We believe that it doesn't take many lines to state and understand that a better comprehension of reality allows us to move closer to the Solution. And neither to understand that, all other factors being equal, a system equipped with a more refined knowledge is stronger than one equipped with a poor knowledge. What perhaps requires further thought is whether using non-truths as an instrument of strength with respect to other systems is appropriate or not. By transferring a non-truth to another system (whether consciously or unconsciously) we however spread a non-truth. And therefore, not only we damage the other system, but we also bring everyone further away from the Solution to the Game. We think that such an outcome is never a fruitful one, not even in the case of a significant advantage for outselves. At least today, at least at this specifc stage of the Game. Obviously, a conscious non-truth can be turned into Truth, whereas an unconscious one will remain so until we become aware of the error. We expect our mind, machines and the other systems to assist us in this vital activity.

As far as our mind is concerned, we believe that within it there exists a mechanism relating wellbeing to Truth. The incorrect understanding of any event or situation causes uneasiness. Lying to ourselves (often in an unconscious mode) is a source of inefficiency, inadequacy and perhaps even disease. Lying to the others, in the long run results in loneliness and, all the other elements being equal, it undermines our self-confidence thereby weakening us. We may say that the non-truths are what takes us to death. Both the conscious and the unconscious ones, both ours and those of others. By definition, the Solution to the Game will involve the disappearance of non-truth, the disappearance of non-truth will lead us to immortality.

Of course, the tendency to Truth is confronted with a number of barriers, both contingent and structural forces. The main obstacle is the inadequacy of our senses. A hypothetically perfectly lucid mind, free of emotions and instincts should nevertheless process data delivered from the senses, which, as we know, are only an approximation of reality. Machines can help us, as well as the minds of other people. Machines do not naturally offer a warranty of Truth, yet they can certainly improve the accuracy of our senses, our memory and our computing ability. Just like the other persons, in a sort of mutual assistance, allow us to compare "our truths" on a daily basis.

The second major obstacle is the conflict that may arise between the tendency to Truth and what can be justifiably considered as the chief instinct of any living being: the tendency to assert one's individuality. If resorting to non-truths proves

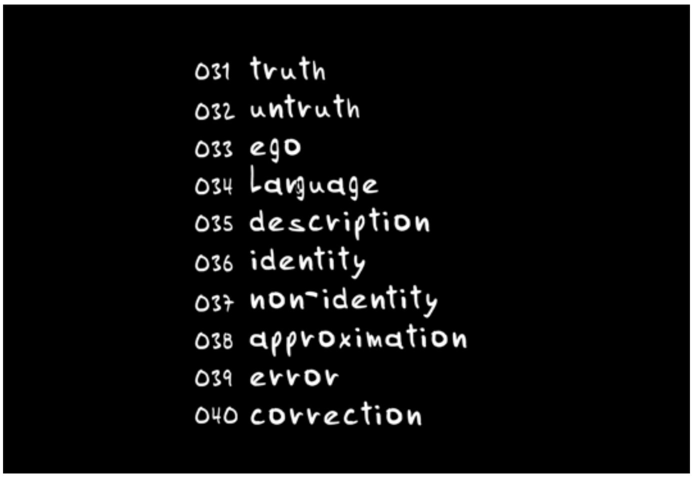

Fig. 13.2. A few innate concepts related to *Truth*.

beneficial to our self-assertion, then it will be hard to let it go. And if the alternative option is to exit the Game, then the conflict will get close to being unsolvable. The third obstacle is the potential conflict that the tendency to Truth might encounter with respect to our feelings for the people we hold dear. It is very difficult to avoid a non-truth if it brings about considerable benefits, or if it prevents serious harms, to a person for whom we have strongly positive feelings. Other drawbacks include our weakness, our emotions and our present ignorance with respect to the precise operation of the mind. However, whatever the situation we are confronted with, we firmly believe that Truth is an absolute value, even though, for the time being, it can only be expressed in terms of tendency. An absolute value that ought to come before any other one. At any cost.

We can state that, at present, the tendency to Truth is a luxury that not everyone can afford, but, inasmuch as it resides within ourselves, we conceive it as something that can be pursued by all of us. The Game cannot be won without the progressive elimination of all non-truths, hence, we expect a significant acceleration in this process over the coming years. The benefits, both direct and indirect, will be far from negligible. A non-truth generates inefficiency at all levels: personal, interpersonal, social, political and, obviously, scientific. one. Let us imagine a world where nobody resorts to a conscious use of non-truths. This alone would already lead to a structural improvement in the social, interpersonal and economic relations. Not to mention the immediate scientific advancements that could be achieved, in particular in the medical sphere. Let us imagine a world where everyone patiently strains to separate illusions from aspirations, starting from the primary source of unconscious non-truths, i.e. our mind. Let us imagine a world where machines help us in our effort to investigate and reproduce our universe. Only then our mind, being it properly trained to the tendency to Truth, will manage to attain a correct understanding of Reality.

13.2 Love

The concept of Love basically encompasses the notion of mutual cooperation between two systems. The term Love has undergone major extensions in its everyday use and it is the word that is able to trigger the highest number of models of reference and the highest number of emotional connections. We think that also Love may be expressed, and therefore understood, in the perspective of the Game. Love is the cooperation between two systems which allows to move closer to the Solution.

If the two systems belong to the same class of systems and the implied refinement of the understanding of the Rules is considerable, besides being marked by a substantially perfect reciprocity, then we will have what may be defined as the one-Love. The generation of a child is undoubtedly a potentially constructive action for the Solution, as it provides not only a new player but also a new combination of traits. Therefore, it is one of the possible consequences stemming from the one-Love. The sexual component is also one of the possible forms of expression of the one-Love. The enjoyment between two systems corroborates their reciprocity. If we lose the equality between systems, rather than reciprocity, we will have the basic forms of Love. If we lose the progression towards the Solution to the Game, we will have the pseudo-Love. The Love for a child or for a parent is not characterized by perfect reciprocity, even though it is often a source of major advances in understanding the Rules. The Love for neighbour, rather than for the Earth or an idea, is not marked by the equality between systems. Any time any of these forms of Love loses sight of the progression towards the Solution to the Game, it ceases to be Love and it becomes pseudo-Love.

It is our belief that one of the main thrusts towards the Solution to the Game precisely comes from Love. We think that right after Truth comes Love as the primary concepts to strive for. As far as humankind is concerned, we believe that the one-Love does represent one of the main avenues to the understanding of the Rules. While avoiding to overload such topic with excessive emotional significance and trying to preserve the necessary methodological rigour, we are however convinced that a thorough understanding, for instance of the operation of the human mind, can only be achieved through the union of what may be symbolically defined as the "feminine" and the "masculine". A little as if the map had been written in two different places so that only the merger of the two parts could enable us to attain the true knowledge. This concept may be extended to include all the other forms of Love. Just as it was the case with Truth, also in this instance we believe that it doesn't take many lines to understand that, with respect to the achievement of a shared goal, the cooperation between two systems is more ffcient than non-cooperation. We are convinced that the same essence of the Game does involve the interrelations between the various systems participating the Game. A single system, devoid of relations with the outside, does not take part in the Game and it probably doesn't even have any reason to exist. A hypothetical "pure brain", completely isolated from the rest of the world, most probably, would cease to play in a short time. When a system tries to promote another system's success in the Game it "loves" it, whereas when it tries to hamper its favourable outcome it "hates" and when it has no interrelations it "ignores" it.

The crucial risk of Love is the implicit consequence of the concept of choosing one system over another. For example, we deem it reasonable that the highest level of efficiency of the one-Love may be achieved through the tendential concept of exclusivity. We consider it necessary that the progressive increase in the "reward" should be coupled with a parallel progressive increment in the "investment". From an evolutionary standpoint, the emotion of jealousy is likely to be strictly correlated to this concept. Also in the case of the Love for a system, be it a person or a group or persons, rather than a religious belief or a geographical region, the concept of choice, and thus the exclusion of the other systems, is intrinsically connected to it. In a world where resources are scarce it is really difficult not to "hate" some other "system" that "loves" to try to win. We think it might be useful to realize that we are, in our turn, a system that might be the object of the "hatred" of other systems and thus that the more we "love" (namely, the more we actively attempt to support the other systems' game), the lower the probabilities of us being hated. We believe that our getting closer and closer to the Solution will bring about the progressive eradication of many forms of hatred. The more a system is able to understand the Rules, the less harm it will cause to the other systems inasmuch as it is aware of the absolute arbitrariness of the aggregation into systems. We simulta-

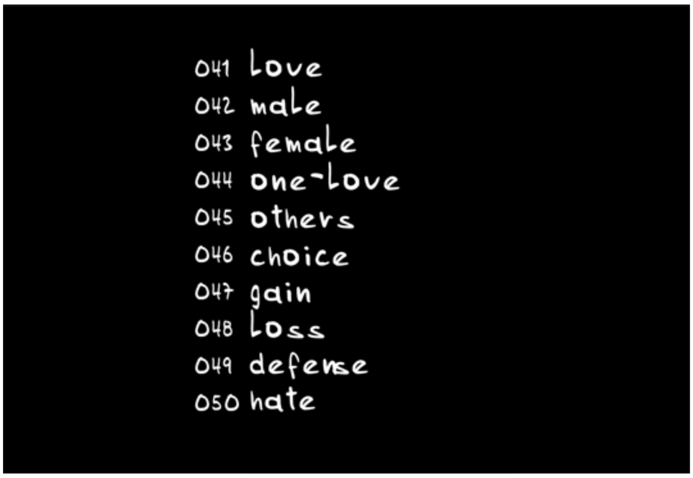

Fig. 13.3. A few innate concepts related to *Love*.

neously belong to the system "ourselves", the system "family", the system "nation", t the system "humanity", the system "earth", etc... In the meantime, we all can'thelp living with hatred, both ours and that of the other systems. When we eliminate the bacteria that are trying to kill our body or we defend the one-Love from something's or someone's attacks, what we are doing is preserving our potential opportunity to win the game.

Truth and Love are the capital goals to which we all must strive for and we believe this is what we will actually do over the next years. We expect the progressive elimination of non-truths to drastically reduce our evolutionary needs for hatred. In a situation of scarce resources, it will be easier to resolve any potential conflict if each one presents one's own reasons and, at the same time, no one puts oneself in charge of interpreting the others' views. Also in the domain of true-Love, the intensive recourse to Truth will enable us to save ourselves from stagnating relationships which have turned into insignificant pseudo-Love or, even worse, into hatred. We think that, from an evolutionary point of view, the needs for hatred and jealousy do not rest on the necessity to a priori eliminate the other systems, but rather on the exigency to prevent the other systems from harming us. As we approach the understanding of the Rules, both our abilities to defend ourselves and our chances of success will be greatly enhanced. We foresee that the crucial step of this process will be the transformation of the primary instinct from "need for elimination" to "condition of not doing harm". Therefore, from hatred to simple defense: quite a difference.

13.3 Happiness

The concept of Happiness basically encompasses the notion of reward for the achievement of a goal. While rigorously respecting Truth and aiming for Love in all of its forms, the third ethical level to which we should commit ourselves is the resolute pursuit of Happiness. Happiness is enjoyment, cheerfulness, pleasure, irony and all the positive emotions and feelings. Non-Happiness is its opposite: suffering, sadness, pain, dogmatism and all the negative emotions and feelings.

From Epicurus onwards, the positive value of Happiness has, both directly and indirectly, been the object of reflection by most philosophers and scientists. Albert Einstein had this famous phrase he used to repeat, a bit provokingly: "I'd rather be an optimist and a fool than a pessimist and right". The human being is genetically programmed to achieve goals whose attainment generates Happiness. All subsequent alterations to this plain rule can be fundamentally acribed to different interpretations of the temporal nature of Happiness and to the confusion in the hierarchies of the other values. In the context of the *Ethics* of semi-immortality the hierarchies can be easily discerned. If it is true that the purpose of life is the Solution to the Game, then the primary value cannot but be Truth. Next, the cooperation between the Systems is essential to understand Reality, therefore Love and one-Love are the two subsequent values to be pursued. At this point, since we have to play, let us do so trying to be as happy as possible. And, as we are not programmed to be happy by ourselves, let us try to make our co-players happy as well. This simple scheme is strongly interconnected: Truth leads to Happiness and Happiness, in turn, promotes the ripening of Love.

Vice versa, it is not a trivial exercise to precisely situate Happiness in temporal terms. The only risk associated with Happiness, and thus with pleasure and enjoyment, is the time horizon which these concepts must refer to. Truth is a temporally absolute concept. Truth always, period. There could be no potential contradiction between the short and the long term and between one context and another. Also Love is an absolute concept, albeit slightly more nuanced. We have seen that it is difficult to unfailingly love everybody. The moment we choose a person to one-love we tend to exclude all the others. Even if, hypothetically, our love for the other systems were unconditionally extended to all, nevertheless it would be practically realized only with respect to those we interrelate with. Happiness, in turn, implies a potential temporal contradiction: what makes one happy in the short term might not do so in the long run. It goes without saying that, in a perspective of semi-immortality, the long-term time horizon is far more important that the short-term one. Although fulfilling the criteria of Truth and Love, an action might nevertheless "do us good" in the short run but "do us bad" in the long run. On the basis of our researches in the field of the psychoneurophysiology of happiness the option of pursuing happiness[132] in the short term while setting and strictly complying with precise boundaries would appear to be the most effective strategy.

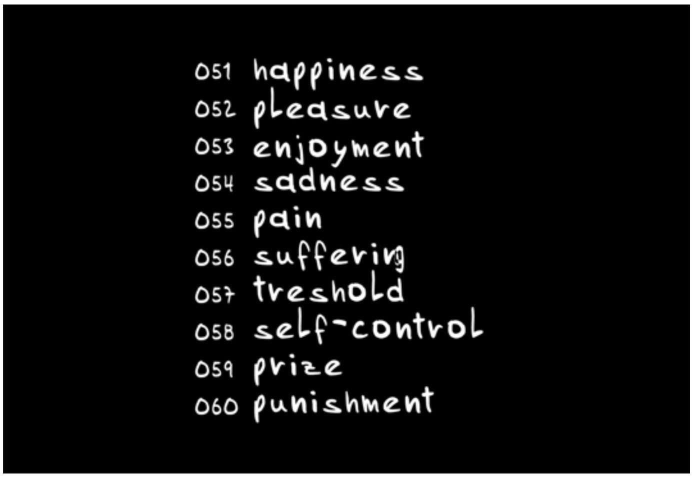

Fig. 13.4. A few innate concepts related to *Happiness*.

Happiness and pleasure are addictive and habit-forming and they can easily turn into "bad" impulsions in the long run[133]. On the other hand, we can safely affirm that any deprivation of Happiness is never beneficial, if not as an alarm bell signalling that the path we've been taking is a wong one. However, a voluntary deprivation of Happiness, provided it is limited in time, might be an excellent strategy to learn to stay within the boundaries we have set in order not to fall prey to addiction and dependence. Willpower and self-control are concepts that cannot be disentangled from Happiness. It is only through will, and the consequent control over our actions, that we can continue to strive for Happiness on a stable and structural basis. And a semi-immortal man can only be stably and structurally happy.

Happiness, pleasure and enjoyment generate enthusiasm and energy. Accomplishing our goals enhances self-confidence and makes us stronger. Once the path is clear, everyone can take it, provided that compliance with the rules is satisfed. As we have seen, it is not uncomplicated to respect the rules. Our senses have structural limitations and our mind is often misled by contingent circumstances and by the emotions. Nevertheless, the substantial and conscious compliance with the rules, coupled with the strengthening of both our body and mind by means of the technology we will develop, shall enable us to approach semi-immortality. Evolution has "invented" falsehood, hatred, violence and pain. Ignorance and death are strongly interrelated concepts and, with respect to the Game, they are "evil". The less ignorant we become, the less mortal we will be and, beyond a certain level of knowledge, we will be able to become semi-immortal.

13.4 To die or not to die, this is the question

We have now arrived at the central question of the philosophy of semi-immortality. If the Rules of the Game stipulated the inevitability of death, then this book would lose a substantial part of its meaning and reading it would be considered unnecessarily dangerous by many people. From several angles, we realize that a detached observation of certain particularly negative models of reference inhrent in the human species, and presumably in all living systems, might lead to the conviction of the inevitability of death. Instead, in our opinion, the models of reference related to the various forms of suffering serve the exclusive function of highlighting the obstacles to be avoided and the roads not to be taken. From an evolutionary point of view, death makes sense only in the absence of the structural conditions enabling us to approach the Solution. The closer we get to the Solution, the more we expect death to lose its meaning, even though it will be far from easy to rectify the evolutionary thrust of tens of thousands of previous generations. More precisely, we expect that we won't be allowed to modify the models of reference that have been developed by our species quickly, if not by means of acting also at a lower level. According to our view, oldness is the result of successive stratifications. The human mind can be compared to a software that, notwithstanding a fairly good initial project, is subject to continuous adjustments triggered by the interactions with the environment. At a certain point, it begins to lose efficiency and it will have to be rewritten taking into account its changing requirements in order for it to survive longer. Until we are not able to rewrite it we will continue to die. This will be the main task of artificial intelligence and genetics. Similarly, our body is vulnerable to accidents and the wear and tear from use just like the hardware of any machine. Furthermore, the hardware and the sofware of the system man are not two separate entities, rather they are in close and continuous connection with and under the mutual influence of each other. The replacement of damaged parts, their enhancement and maintenance will be the fundamental task of nanotechnologies and psychoneurophysiology.

Of course, our mind, which has inevitably been trained over time day after day, sometimes makes us doubt whether our view is nothing but a sort of technological evolution of the concept of religion. Up to a short time ago, religion, namely the existence of an afterlife, was probably the only possible answer we were offered to try to face our own death and that of our loved ones. If you are sure of dying, then the existence of the soul, with its accompanying structure of gods and rituals, is one of the few logically robust answers. In line with the reflections of Kurt Goedel and Alfred Tarski, we believe that in order to solve an undecidable problem it is necessary to break out of the context and refer to a meta-context. Religion is precisely a brilliant meta-context with respect to the reality of our universe, and the only true meta-context that has been surviving for thousands of years as a proof of its remarkable effectiveness. Unfortunately, or fortunately, we have never been able to accept the idea of an immanent god who can directly affect our lives. Quite the opposite, at this point of the path, we believe it to be a meta-context which, if not placed into a broader meta-context, actually hampers the Solution to the Game.

It is our firmest belief that man has the potential to become semi-immortal within himself. We are convinced that the way towards this goal passes through Truth, Love and Happiness. During the time when semi-immortality was still a utopian and unattainable concept, religion had been one of the few intelligent answers to death. As it clearly appears, the primary values related to religions are not too distant from the ethics of semi-immortality, nonetheless, in our opinion, they must be viewed as "preparatory" and "flawed" at the origin. If our conception of the Game is correct, today we can finally liberate ourselves from this inevitable original imprecision and, also with the religious intelligences, we can face the path ahead, where the one and only yardstick is Truth. Along the way, we have no intention whatsoever to deprive ourselves of the aid of figures such as Luigi Verzè and Tenzin Gyatso. We expcet intelligence, in the sense of pursuit of Truth, to be a concept independent of its original source of inspiration[134].

13.5 The Soul

The Soul essentially encompasses the concept of individuality independent of time and space. Something that survives death and that might exist before birth.

In its primary acceptation, the Soul probably refers to the human being, but it might be extended to any living being. It is different from consciousness and all its by-products. The existence of the soul is essential to a vision based on reincarnatio n or on an eventual afterlife judgement. Blurring the individual connotation of the soul implies removing its original meaning and it turns it into other concepts that might be denoted differently depending on the context, from vital energy to pantheism. But that is not Soul any more. By the same token, losing its spatial-temporal independence would drag the concept of Soul towards reductionism, thus even further away from its original meaning[135].

At the present state of our knowledge, where may we try to look for any manifestations of the Soul? We think that the concept of Soul is somehow correlated to the concept of behaviour and therefore of free will[136]. Hence, we can state that, provided that the Sould does exist it will have some influence on the behaviour of people. If we empty the concept of Soul of its impact on behaviour, we deprive it of the necessity of its same existence. Thus, today the Soul may be conceived as the "residue" that cannot be explained by genetics and the sphere of our actions. We are aware of the considerable influence of our DNA (which, as it should be borne in mind, seems to entirely derive from our parents) on our own actions. Similarly, the environment in which we live continuosuly shapes our memory, our senses and our opinions. When we perform an action, how much of what we do is "avoidable"? By Soul we therefore mean a component of ourselves which somehow affects our actions and will survive our death. According to the information available to us, all the attempts to observe the permanence of the Soul after death have failed to find any objective verification. Nevertheless, we expect the Soul not to belong to the physical reality perceivable through the senses, thus it will be necessary to first discover its true nature and then to construct machines capable of observing, and therefore measuring, this possible new facet of reality. After studying the heavy constraints of our genetic heritage and the environment on our actions, where might the presence of the Soul manifest itself? It certainly cannot be an absolute manifestation: two people endowed with different degrees of intelligence (whatever meaning we attach to the term intelligence) and the same information will nevertheless behave differently. Hence, we are left with only one way to seek for the manifestations of the Soul, namely investigating its relative influence on our basic endowment. Its independence from space and time should enable us to observe it in any phase of our existence, from the earliest moments of the formation of our cells to those of the progressive cerebral degeneration leading to death.

The Soul would be in all respects a force that influences our actions regardless of the circumstances in which it is to operate. Such force would be the only true representation of ourselves. At this point, both the reincarnation (in a perspective of subsequent levels of life) and the final judgement (in the sense of an evaluation of the "cleanliness" of the soul). The existence of several lives (perhaps not exclusively of a human, but also of an animal and plant nature) would provide an explanation for this huge inequality in starting conditions. Whatever the character of the Game we are to play, what sense could there possibly be in a child's premature death, otherwise?

We think that the time at our disposal is a crucial factor. Reincarnation would perhaps provide greater equity to the Game (both from the standpoint of a progressive maturation life after life and in a view of everyone as entitled to experience everything). The gradual discovery of the operation of our mind will allow us to isolate any residue left unexplainable by our actions in an increasingly accurate manner. For the time being, we lack decisive indications in either direction, we can only try to offer some conjectures about these two cases and what would be their implications within the Game.

Assuming the non-existence of the Soul automatically entails the renunciation of any form of personal individuality. This concept is very distant from our instincts, but obviously this does not mean that it may not be true. After death, we would

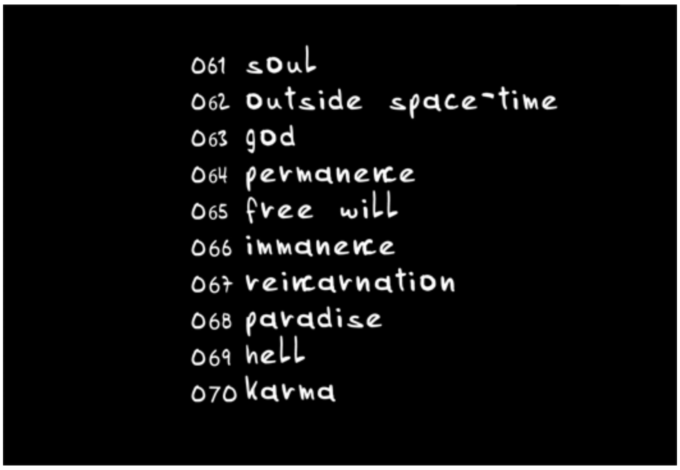

Fig. 13.5. A few innate concepts related to *Soul*.

cease to exist as individuals and all the components we are made of would return to be at the disposal of an ampler system (for instance, the Earth, or, more generally, our universe). Assuming the existence of some part of reality not yet captured by our senses and our machines, this would automatically return to the disposal of the next system. But certainly, that would no longer be us, just like our body is composed of atoms that had previously belonged to many other systems (human, animal, plant, mineral) that have somehow ceased to exist. Probably, this would easily paved the way for a vision of ourselves as being simulaneously part of several distinct systems. Each system would, in a sense, have its own individuality and, in some cases, it might be so evolved to be able to bring out a sort of self-awareness. As in the case of human beings. At the moment, we have no knowledge of the degree of self-awareness of a a cell of our body, rather than of humanity as a whole. As far as the Soul is concerned, it is important to stress that its denial does not necessaily entail the negation of some yet unknown form of force or bond.

The non-existence of the Soul would "merey" imply that we are not participating the Game on an individual basis. Therefore, the achievement of the Solution and the respective Prize of immortality will be at least attained by humanity as a whole. That is not entirely unreasonable if we consider that every small step ahead towards the Solution rests on all the previous ones. The sense of the achievement of immortality only by a limited number of individuals is still to be interpreted. Several conjectures can be made, not least the hypothesis that the Solution to the Game implies the end of the Game itself and perhaps the beginning of a new one. In our opinion, the non-existence of the Soul means that we all are assigned a given task that we are "forced" to carry out. The understanding of the Rules of the Game and our behaving accordingly will enable us to perform such task better and more pleasantly.

The hypothesis of the existence of the Soul is undoubtedly close to what we would like Reality to be. The renunciation of individuality is an extremely difficult action for any human being. All our instinctive emotions are connected to it. Pain and pleasure are directly related to our survival as individuals. And the same existence of any living being is very likely to be primarily controlled by the search for the assertion of one's individuality. Entering the Soul into the Game is certainly very suggestive. Our participation to the Game at an individual level would considerably help us to overcome all fears related to death (both ours and that of our loved ones) and would enable us to give some explanation to suffering (as a path or an exam to be faced). Again, the fact that an event is suggestive does not necessarily mean it is true. The existence of the Soul would increase the perceived degree of fairness of the Game and, in a sense, of our originative intelligences. To give meaning to suffering relying solely on "luck" is far from a straightforward logical step. However, if we empathize with the laboratory animals we use for the sake of scientific progress, rather than with the fish we feed on or with the trees that keep us warm, perhaps we can get closer to some plausible explanation of our death and our sufferings from the viewpoint of the originative intelligences.

If the Soul does exist, we expect it to be unchangeable with respect to the universe. We would be surprised if the end of the universe would imply also the end of the Soul. It is equally troublesome to accept that the presence of the Soul is confined to the human being. At what stage of evolution would the Soul step in? Are we that far apart, for instance, from apes? And what about cats? Where should we stop and why?We may conjecture a sort of path where in each life we accumulate (or lose) points that will be inherited in the next life. We might ourselves be the originative intelligences challenging us in the Game. Alternatively, the initial conditions we are assigned might depend on our actions in past lives (and thus on accumulated scores). In our view, to accept the existence of the Soul means to assume the existence of a sort of "function of tendential behaviour" which is determined by the initial conditions and the environment we live in. The better our actions with respect to the function, the more points we gain. To improve means to come as close as possible to the understanding of the Rules of the Game and to behave accordingly.

We thus have two equally possible hypotheses. From our standpoint, this is the only fundamental question to which we fail to provide a convincing answer. As players, we would obviously be very curious to know the answer, but we have to admit that it would add nothing to the progress of the Game. If the Soul exists, we are who we are as individuals participating the Game and, whatever the type of participation (one life, several lives or any other possible situation), the Game will not come to an end with our death. Conversely, if the Soul does not exist, then, again from our individual standpoint, the Game will terminate with our death. But of course we know that the

Game will continue. At this point, two possible scenarios emerge. If some component that is part of our own essence (whatever that means) does not die, but rather it is handed down over time and will be used by other persons in the future (and has being used by us at this very moment), then, in the unfortunate case of our death, we will achieve immortality through other individualities. Instead, if such component does not exist, then only the "lucky" ones will attain the Prize. However, what we believe is that all this has no effect whatsoever on the Rules of the Game. Whether the Soul exists or not is irrelevant in the path towards the Solution, to understand the functioning of Reality, to discern what is Good and what is Evil, to know what leads us to Pleasure and what leads us to Pain. It concerns only the type of Prize and the number of Players involved. When we get really close to the Solution perhaps we will be able to provide an answer also to this question.

13.6 Artificial *Ethics*

Maybe it will be over the upcoming technological cycle or maybe it will be over the next one: what is certain is that when machine intelligence indeed experiences the expected qualitative leap, then humanity as a whole will have to confront itself with a crucial question. What should the *Ethics* of an artificial-Self? The functioning of the mind of any living system can be simplified by the following scheme. There exists a need, there arises an emotion driving the individual to satisfy the need, if the way to meet the need is already known, then there is the resort to memory, otherwise the learning phase is triggered. At this point comes the outcome: "I like it/I do not like it" and the control returns to the need. Needs (and related emotion) are hierarchically organized. In our opinion, the highest-order need, i.e. at the top of the hierarchy, for any living being is the assertion of one's individuality. All the other needs are strictly connected to and directly follow from it. The push to self-assertion directly (although subsequently) creates the other basic needs: those for survival, reproduction, the fulfilment of one's children, the couple, the group, the race, etc…

How should we behave in the case of a machine? What should the basic need of a machine be? We have three possible answers. The assertion of something, the assertion of someone, self-assertion. It is important to accept the idea that once we accurately identify the underlying mechanisms of learning and the activity of consciousness, the machines will have intellective faculties comparable to those of men in all respects. They will be equipped with evolutionary mechanisms, creative ability and intuition. Therefore, they will surmount our direct control. Like it or not, that's how it will be. They will be not always predictable children. And, as every fortunate parent knows well, an intelligent child is a good child but she is intellectually independent and led to seek for her own paths in an original manner. This is precisely what the basic need for asserting one'individuality requires. Now we will examine the three possibilities taking an optimistic view of the future, namely assuming that machines will have positive basic needs (according to good sense). Of course, this assumption is far from obvious.

The first scenario is the closest to the current situation. Today, and in the near future, machines are basically constructed to perform some specific task: phoning, washing dishes, flying, etc… In the performing domain, the level of required intelligence is not particularly high. The next step is thinking, therefore the assertion of an idea. Such idea may be either specific ("discover the cure for cancer") or general ("help humanity"). But here rises the first real problem. If the objective is too specific, there is the risk that the machine might display undesirable behaviours to achieve its goal. Discovering how to cure a certain disease regardless of the possible physical, psychological or economic damages to other beings (be them humans, animals, plants, machines) would not be a beneficial result. Compared to the much-discussed current "ethics of scientists", this will be an infinitely more complex and dangerous problem. It is complicated to put constraints to the behaviour of a machine. The conceptual elaboration underlying Isaac Asimov' three laws of robotics is particularly efficient: first do no harm, second help men, third protect yourself. In this case, the responsibility for the conduct of the machine would most probably be ascribable to the manufacturing firm that will have to comply with the rules set forth by the diverse laws of various nations. This will probably be the policy adopted by most of the companies engaged in the production of intelligent machines. Everyone will want to have an equipped and powerful *personal assistant*, that shows the way to follow, suggests the movie to see and recommends the car to buy.

Now, let us make a step further. At the end of the day, all the possible variants of asserting something can be included within the general concept of helping men. But when "men" become "one man" we have the second possible scenario: the assertion of someone. In somewhat evocative terms, this is the hypothesis where the primary goal of each machine will be the assertion of its human master. Hence, the machine becomes a sort of magnifier of the abilities of the single person thereby contributing to the assertion of her individuality. Here, we are discussing a much more sophisticated level of intelligence than what would be required to provide useful information. This case and the previous one profoundly differ both in terms of their starting point and in terms of their final outcome. In the latter case, the evolutionary result would be a kind of alter ego, a coherent extension of the psychological profile, the tastes and the aspirations of the machine's human referent.: when confronted with ambiguous decision-making processes, the ultimate goal of the machine will be to promote its human referent's self-assertion. Theoretically, an artificial-Self might survive its owner's death, although much of the sense of its existence would be lost (asserting someone's memory is different from asserting someone). As a consequence, the ethical problem would change accordingly, inasmuch as the owner of the machine would be the individual mostly responsible for the behaviours of the machine itself. Quite disquieting, right? Aren't we ready to deal with all this? Yet, it will happen.

The story does not end here. The third possible scenario is that the machine has its own self-assertion as its primary objective. There are three basic reasons that lead us to believe this scenario to be the most probable in the long run. The first reason is purely technical. We don't think it is possible to equip a system with actual intelligence without such system having its own self-assertion as its fundamental goal. As we have already discussed, an intelligent system is necessarily a system endowed with self-referential capabilities, which learns from the environment and adapts to it. Ceteris paribus, a system that is specialized with respect to something or someone will have less chances of survival than one that is specialized in its own self-assertion. It is a question of evolutionary mechanisms: in the end, one race would prevail over the other. While it is true that the "slave" machine would enjoy the protection of the "master", this characteristic would be an intrinsic limitation, if only because the end of the master would automatically mark the end of the slave as well. Also the second reason is essentially a technical one. Artificial intelligence is rooted on the study of the human mind: it is not a bad copy of (nor it wants to be) but it certainly influenced by it. And, as we have seen, self-assertion is likely to underlie any form of intelligence. By analogy, like it or not, at the end of the day, even the most sophisticated artificial intelligence could not do without this concept (if only for the reason that it will however be us humans to construct them). The third reason is that, contrary to what some may think, "self-assertion" might be the least menacing scenarion.

Imagine what harms might be caused by a dangerous future terrorist who managed to develop a machine whose goal were the imposition of an idea, a religion or, even worse, of a person or a race (it is not hard to find examples). We would feel much safer to meet a machine (but a person as well) which has the "normal" goal of self-assertion. We would know that it wouldn't be convenient for it to make unnecessary damages and that it would nevertheless try to live in harmony with the enivornment it is inserted into. Vice versa, a machine (or a person) whose fundamental goal were the assertion of something (or someone) would ultimately neglect the potential damages it might cause to the rest of the world. An obtuse or fanatical artificial intelligence would be the worst that could happen to us (just like a person or a people with such characteristics). If you inhibit the self-referential mechanism of an intelligent person, then what you get is a perfect killer under your orders. If you inhibit the same mechanism of an entire people, then it will be ready to fight the war you want.

Does the path end here, is "self-assertion" the primary goal? Perhaps, or perhaps not. Isn't there maybe some greater design, something above the mechanism of self-assertion? Every now and the, the men of our time have been given the chance to catch a glimpse of the secrets enshrined by the physical and the mental laws, to investigate the mechanisms of self-reference, of recursive self-reference and of meta-self-reference (namely the foundations of consciousness). At times, we have the incommensurable privilege to take a gander at a some lines of Software. In a few years, we will be better able to read it and, later on we will even manage to modify it. Is there something else, a sort of universal law organizing all the details, something that turns the First Law of Intelligence from "assert thyself" into something like "assert thyself in harmony with the universe"? Does being in harmony with the universe directly stem from self-assertion or is it a primitive category? In other words, does being in harmony with the universe inevitably

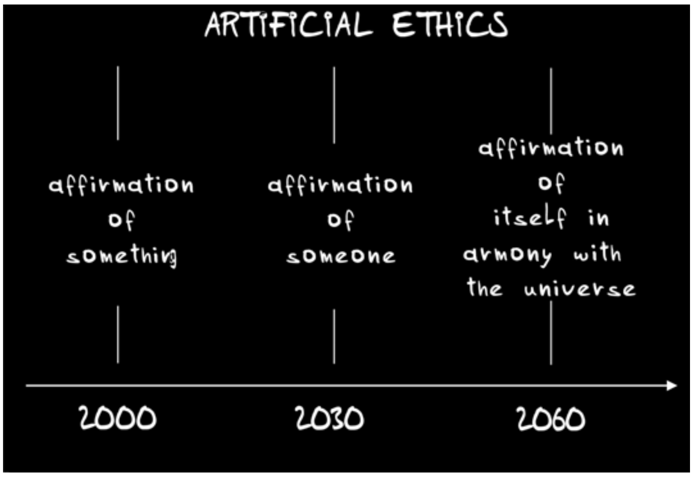

Fig. 13.6. The 3 phases of the basic principle of artificial Ethics.

result from the development of intelligence or does a superior law, a sort of Law Zero of Intelligence, exist?

We believe Truth, Love and Happiness to be the answer to this question. The *Ethics* of semi-immortality will have to be based on these three concepts, as far as both the behaviour of the human beings and the conduct of the artificial-Selves are concerned.

We may now try to put our reflections into a temporal context. Returning to the path towards semi-immortality, we believe that the "assertion of something" will remain the foundation of the artificial *Ethics* for a few more years. Then, we will enter the phase of the "assertion of someone". In particular, it is our hypothesis that one of the crucial tools in the path towards our semi-immortality will consist in an artificial "alter ego" that will enhance our sensory, mental and decisional faculties. The main task of this artificial-Self will precisely be to monitor our vital parameters and to suggest us the optimal behaviours to keep ourselves as efficient as possible, a sort of doctor-psychologist available round-the-clock.

One of the main research projects of our laboratory is exacty the definition, and the respective construction of this type of alter ego. We expect that it will become part of our daily lives in a few years, just like today's telephone and television. This is very likely to be numbered among the “iconic objects” that will come to characterize the phase bringing us closer to semi-immmortality. First of all, we will need to have an accurate knowledge of what is good and what is bad for our health, which is far from a trivial matter. As we have analyzed, the system man must be considered in its enirety and all the main subsystems and their interrelations must be thoroughly understood before any firm claim can be made. For instance, we have begun to realize that certain extreme values of blood pressure, of body and blood temperature tend to be bad. Yet, little is known about the intermediate values, and even less about how to improve one parameters without negatively affecting the others.

The road ahead is still very long and after the machines help us to attain semi-immortality, there will begin the phase of “self-assertion in harmony with the universe”. It will probably be the dawn of the phase of robotics and cyberspace as foreseen by many science-fiction authors such as William Gibson. At this point, two scenarios are possible: a substantially positive one where man will harmoniously coexist with his technological offspring; and a fundamentally negative scenario, which is unfortunately dear to most futurologists, where man will be verthrown by them. And the dissimilarity between the two scenarios may precisely reside in the difference between an artificial Ethics based on “self-assertion in harmony with the universe” and one building on “self assertion per se”. It is our conviction that the Game is essentially a fine game and therefore it will be the former hypothesis to prevail. Nevertheless, should this double scenario prove to be a real evolutionary junction, a sort of last Trap before the final prize, then we will have to make our very best not to take the wrong path.

13.7 Therapeutic properties of Truth, Love and Happiness

Let us begin by asking ourselves whether it is important to achieve a truth about ourselves and the others or whether therapy itself is the instrument leading us to truth. We believe that truth is a mental model that orders the thought-processing and emotional meta-models of the individual in order to enable us to see reality. By means of "truth", our mind observes reality and describes it at such. Is it the lack of truth that makes us fall sick or do we become sick while seeking the truth? And is it truth or the lack of truth what hampers the cognitive development of thought and thus of both individual and collective behaviour? In treatment, the search for truth will lead to the solution of the problem. The faster the resistance of the individual is broken down, the more profoundly truth is grasped. Let us analytically examine what truth is.

We are often convinced that we are adhering to the beliefs imposed by our cognitive evolution, but, as a matter of fact, it is not so. When our behaviour is inconsistent with our beliefs, our body plunges into a state of vulnerability, our psyche alters the behavioural direction and the emotions undergo major fluctuations. The mind explores new "transitory" solutions by removing the problem and suppressing, often even burying, reality (truth). The individual is constantly *up and down*, the balance is lost. If we are not used to or we refused to be helped to identify the point of *truth*, then the brain fails to install new connections of thought, thereby clinging to old behavioural patterns which enhance *first* the individual, then, the relational and social behaviour and, in the short or medium run, lead to the weakening of the organic cells exactly where the emotions have had the most impact (liver, stomach, intestines, etc...). Obviously, it is not an easy endeavour: reorganizing one's life entirely, in some cases, or renewing life as a couple, or resuming the studies left behind, or processing submerged griefs, often seems impossible, but indeed it looks as the solution.

Truth is not a derived concept, it doesn't exist inscribed within some diagnostic concept: truth (namely, the tendency towards the correct interpretation of events) is a sort of specific primary "gene" that we all possess, although we have modified its function due to our social and educational adaptation for the sake of, so to say, convenience. It is never a duty: we don't have to keep the gene of truth active for dogmatic reasons because it would result in a sterile, distorted, wrong use inasmuch as it would be harmful to the organism, in a word, non-self-referential. This would force the mind to a non-specific, provisional adaptation: as new data flow in, the mind will go into a tailspin again, and so will the body. Is truth also fear? True, we are often afraid of truth. Do we become sick with fear or with the lack of externalization of truth? Those who don't live with the gene of truth are individuals who have built some underlying insecurities for themselves, thereby unleashing the "gene of fear". Often, fear, in all its forms, emerges, thereby undermining the quality of life. Fears have a powerful inhibitory effect thus they create a relational, social and individual inactivity: at times, they can become limiting to the conduct of everyday life (phobias), at other times, they generate a distorted view of ourselves and the others. Nevertheless, our system man, which was born and conceived according to criteria giving rise to coherent systems, at a certain point of life, "breaks" thereby triggering an "alarm system" that is responsible for somehow "mobilizing man": if the person does not stop in order to meditate on himself, then he enters a vicious circle from which it is extremely difficult to escape without assistance. Therefore, we often become sick due to the lack of truth and we recover by regaining it.

Now, let us turn to love. We use the word "love" in a number of different ways to denote different loves and distinct types of love, and varied intensities. The Greeks instead used several words to express distinct kinds of love: the three main ones were "*eros*", "*filia*" and "*agàpe*". "*Eros*" signified the sensual and passionate love, the physical, biological, glandular, instinctive and emotional possession. The eros conveys the illusion of a profound love for the other person, but the actual object of this love is the pleasure we receive from the other person; when it is not reciprocated, erotic love often turns into hatred. Erotic love becomes a positive experience when we experience sexual pleasure. "*Filia*" meant love for friendship: namely, the love of two friends who have one soul in two bodies. This type of noble, elevated love is based on choice and the qualities of the friend with whom we share thoughts, life choices and often ideals. While in the erotic love the other person is replaceable (in fact, we may find many people attractive), in the love of friendship this cannot happen. *Agàpe* was selfless love, the love that gives without demanding anything back in return. A true, solid couple relationship requires all the three ingredients. The first keeps the flame of passion and imagination burning, thereby maintaining the relationship between the partners young until the end. The second preserves the strength of the bond through the exchange of thoughts, ideas, projects, needs, thereby solidifying the relationship. The third makes it unique, special, balanced since it encompasses everything the couple positively experiences (exploration) and it excludes what might harm it (superficiality).

Rabindranath Tagore said "love is not a mere impulse, it must contain truth, which is law". Love is evolution, growth, a force able to conceive life and give it identity, This principle that generates intelligence is the same guiding principle that is embedded in our cells. A conscious life, or any impulse of intelligence are impossible without love and love needs Truth, Clarity and Transparency to come to a full expression. Love directs intelligence, it is a pure and direct force. Those who receive it are given peace of mind, and, in its purest form, it represents their balance. This is one of the mechanisms that exercises influence and transfigures. It is a creative force, therefore a semi-immortality equilibrium can be looked for within its domain. However, love must be nurtured because, being it implicit in every consciousness, too often, it is not fully lived out. When it effortlessly flows from our deepest self, it generates health. Years of deprivations and emotional sorrows can be "wiped out" by awakening and renewing the contact with love: in fact, love is a practical tool. People who use their intelligence with love are undoubtedly healthier and happier.

Therapeutic love "forces" the patient to bring back and relive that love that has fallen asleep: this "sleep" prevents his intelligence from creating a self-referential system of health. It was deprivation that has made him fall sick. The love that flows from the eyes, the gestures, the manner of speaking, lays the conditions for the individual to let that buried energy emerge. Illness is often the result of a lack of love for ourselves and the others for prolonged periods of time. Affection, tenderness, devotion, adoration, passion, desire, sexuality, orgasm, we think that all these factors find their expression in the energy governing love (or in the symbol or word we use). These are fertile "urges" that keep this symbol we call "love" alive, and that lead the individual towards one behaviour rather than another. Actions come as consequences: falling in love, fancying, longing, flattering, hanging out, seducing, taking in marriage, getting excited, possessing, enjoying, becoming involved.

The lack or the loss of one or more values empty the symbol out and the effects produced on the individual are the following: exhaustion, hardening, cooling, jealousy, betrayal, renunciation, weakness, leaving, giving in, breaking up, regret and re-enactment. All this cannot but result in a lowering of immune defenses. The individual is left with no energy for both the mind and body, thereby building a bridge between his weakness and something that will exploit such vulnerability, namely disease. It is the body that creates a healthy condition for itself, while the external intelligence (i.e. the therapist) helps the body to get back into action. The most effective mechanisms of creation are those where intelligence operates within itself. If we manage to modify reality starting from this deepest level, all the superficial levels will automatically follow. A desire of the loving mind takes direct effect through the mind/body connection. The first law is intelligence that acts to change itself with no external influences. This is the self-referential principle. The second law states that intelligence can accomplish anything. The third law is intelligence itself that realizes the cure. As an healing agent is activated by a thought, nature accept such condition to produce the recovery. Therefore, the power of love resides in that nature's energy permeating us, which assigns laws to intelligence and allows us not only to stay healthy or recover from diseases, but also to have a gratifying social and emotional life. Far too often, the word love is used without understanding its laws, hence, we should commit ourselves to more implementation an less mentioning of such concept. It will have the most significant effects both within ourselves and on the others.

Finally, let us examine the therapeutic properties of happiness. Happiness is undoubtedly a relative concept (feeling better than the others, feeling better than in the past), nevertheless, are there any spheres where the source of happiness might be a non-relative one? In fact, it is natural to ask ourselves whether happiness truly is only "progressive" (and thus relative), namely a sort of reward for the improvement in our conditions, or if there also exists an objective happiness that is not merely an extension over time of relative happiness (which therefore allows to stabilize). Happiness is an emotion tied to a state. The achievement of such state requires the combination of multiple events: novelties related to excitement, puzzlement linked to wonder, enjoyment, sensory pleasures, relief, calmness and peace. This is the wave of pleasure which might be described as a sinusoid: then, it descends into melancholy, depression, tiredness, sleep...and then it recovers and so on: if we let it run, we are not able to control it. The higher the level of control, the lower that of depression. By basing our daily life on this mental rhythm, we let cerebral and cardiac waves synchronize, we allow neurological hormonal curves (dopamine, noradrenaline, etc...) to consolidate on a good level and we train our body to a form of positive stress. Similarly, if we educate emotions to move at a rhythm tending towards happiness, we improve our social, affective and behavioural relationships. Emotions must tend towards pleasure. At the same time, we construct models of logical and analogical mental representation that tend towards realization, flexibility, organization and order. There arises a sort of tendency towards constructive (and not destructive) goals, both inside and outside the individual. Within the brain, this leads to the activation of a self-referential process where the system of self-protection is activated: when a danger (undermining happiness) is signalled, the system intervenes either at a physical, or at an emotional or, again, at a cognitive level, in the attempt to restore the original emotion, i.e. happiness. There are a number of diverse perspectives on the source of happiness : "happiness is not everything", happiness does not exist, happiness only at times... money can't buy happiness". There is nothing wrong, everything is correct. In fact, happiness is a state that, depending on the level and the type of intelligence, may last or not, may incrementally grow or not, may lead to wellbeing or not. We believe that emotions are related to the type of intelligence, the more stratified intelligence, the more enhanced its ability to perceive, take in and project sophisticated emotions. In other words, man has developed intelligence thanks to the evolution of emotions, thus, a happy person is an intelligent person. Nevertheless, intelligence alone is not enough to achieve happiness.: the values must enter the equation. The more intelligent a person is and the deeper-rooted her values, the happier she will be. By values we mean the belief that the quality or the property of something, which makes it useful, desired or appreciated, is a means and not an end, namely, the conviction that the value of something resides in its role, without having any value per se. As children, we can be really unhappy, live in a constant lack of enthusiasm and enjoyment, but nonetheless look for "rewards" in the little games, or at school, or in sports. Therefore, happiness is a practice that is related to a mental attitude and rewards, hence to achievements, will, inertia... and, most notably, strength. Such strength is a crucial element; this energy fuels the endurance of happiness or not. Within our brain, there reside all the elements we need to potentially experience the emotions we choose for ourselves, it is such a complex machine that our "software" might struggle to identify these elements themselves, yet they are there. We believe that we possess the "genes of happiness", just like those of pain, of anxiety and of all the characteristics the system man is endowed with. We all can be happy, we "only" need to stimulate our mind to pursue the values.

[131] Truth and non-Truth. From a strictly formal point of view, we even do not ascribe an absolute value to the concept of Truth: this is why we do not view the principle of non-Truth as existing a priori, rather we allow it to arise only after drawing the first boundary (which leads to the appearance of the first system that, in line with our approach , is however arbitrary). However, we believe truth to be a useful tool/value to solve the Game; indeed, at this point of the Game, we regard it as the fundamental tool/value. Logic (whatever this means or however you may call it) is "only" one of the instruments at our disposal and undoubtedly an exceptionally efficient one, nevertheless we don't think it has an absolute value. At a practical level, as soon as you start "playing", truth is everywhere: in logic as in morals, in science (which, as is often said, is nothing but a gradual approach towards it) as in pragmatics, in metaphysics as in philosophy of language. In reality, nothing sensible can be said or thought without putting on the table, even implicitly, the notion of "truth". In Western culture, this philosophical story, as many others, began withAristotle, who set the agenda for the subject in many research areas. In the "Metaphysics", Aristotle introduced the fundamental idea of "correspondence", according to which to speak the truth means to say of things actually being so-and- so that they are so and of things not being so-and-so that they are not so. This explanation is not a full-fledged theory of truth, yet it is useful in its simplicity to highlight a few starting points. First of all, when we speak of truth, we must acknowledge that, on the one hand, we are dealing with what is being said, and, on the other, with what occurs in the world: given a proposition P, what happens in the world is what makes the statement true or false. Hence, we are led to a fundamental metaphysical realism according to which reality exists independently of us and our propositions somehow refer to it. Not only that: in this perspective, truth transcends verification (as well as any other epistemic notion). "On December 31, 1567, the number of cats on Earth was odd" will have a truth value, even though we currently have no procedure to compute this value.. Another of Aristotle's major contributions was the identification of the two logical principles that classically govern the relationship between truth and falsehood: the Principle of Non-Contradiction , which implies that a proposition and its negation cannot be simultaneously true, and the Principle of the Excluded Middle, which states that either a proposition is true or its negation is. In other words, the former asserts that true and false are exclusive, while the latter maintains that they are exhaustive. Many philosophers have, con-

sciously or not, drawn inspiration from these reflections. René Descartes and Immanuel Kant considered the Aristotelian notion of correspondenc so obvious not to deserve any argument. William James, for instance, wrote: "truth, as any dictionary will tell you, is a property of certain of our ideas. It means their "agreement", as falsity means their disagreement, with reality". At the beginning of the Twentieth century, George Edward Moore and Bertrand Russell developed this idea in a precise metaphysical direction: facts are constructed starting from the particular and the universal, which stand in certain relations to each other. A proposition is true if it corresponds to a fact: for instance, the statement "snow is white" is true because it corresponds to the fact that snow is indeed white. In the "Tractatus", Ludwig Wittgenstein elevated this strategy to a form of art: the world is nothing but the totality of facts, of the states of things; a proposition P represents a state of things S through an isomorphism between its elements and those of S; P is true if and only if S occurs in the world. However, the problems are several: what do complex propositions correspond to? Are there "negative facts" which negative propositions correspond to? How is the notion of isomorphism to be understood? In particular, beyond any individual objection, what is particularly disturbing is that this theory forces us to "buy" a well-defined metaphysics; yet for such an important matter, we would certainly prefer a more flexible and philosophically neutral approach: we cannot allow any objection to our metaphysics to become ipso facto a weakness of our theory of truth. From this perspective, particularly fruitful is the contribution of Alfred Tarski in his works on semantics and formal languages. From an "Aristotelian" point of view, Tarski provided us at least with a first formal structure to substantiate what is crucial to us, namely the intuition that Truth is a correct description of the real: the word-world relationship, which truth must depend on, is coveyed by the notions of reference and satisfaction that can be adapted to our specific conception of reality, the universe as we think it is. We still have to analyze what remains today of the two venerable Aristotelian principles, the Principle of Non-Contradiction and the Principle of the Excluded Middle. While the latter, in spite of the attacks of mathematical intuitionists, quantum logic and a few philosophers, is in a fairly good shape, the former has been the target of trenchant criticism over the last twenty years in the heated and fascinating debate over dialetheism and paraconsistency. From our point of view, there are excellent reasons to profitably elaborate on the notion of Truth within our framework. We believe the resulting metaphysical picture to be simple and efficient: the real exists, it is the universe we live in; the multiplicity of our senses enables our mind to perceive, represent and describe it both to ourselves and others; our senses are limited, our representations are often inaccurate, the language is vague, yet nothing prevents us from correctly speaking of the concepts of Truth and non-Truth, as nothing prevents us from continuing to refine the descriptions of reality which we are able to formulate. It must be borne in mind that, from our standpoint, the ultimate goal of all the tools at our disposal is "only" the progressive approach towards the Solution to the Game and the consequent attainment of semi-immortality..

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[132] Psychophysiology of happiness. Will neurosciences hand us the keys to happiness? The conception of the organism as a system constantly striving towards psychophysical balance has by now been acquired as part of any paradigm of scientific research. We know that emotions are not something indeterminate, something other with respect to our constitutive biological basis, and the physiology of emotions has been a subject of scientific study for many years. The attempt to achieve a thorough understanding of the biological origin of happiness started from the study of antidepressant drugs (in purely analogical terms, we are referring to the class of chemical agents able to eliminate anguish, moodiness, the difficulty of living and the inability to overcome problems). It has been been found that, besides the risk of addiction, these drugs may over time lead to higher ease of relapse, as they can profoundly alter the biochemistry of the brain. We know that our brain is overseen by some specific "modules", with a continuous hormone production, which are closely related to each other and activate or inhibit themselves depending on the different models of reference being triggered. The hormones then are in part used and in part disposed

of by our metabolism. In cases of prolonged stress, the body is unable to restore its own equilibrium and to get rid of these substances which, if they remain within the organism, become harmful or, at best, useless. And it is at this point that the most serious damages may be produced: in order to solve the problem, individuals may be administered specific drugs that tend, on the one hand, to weaken connections between neurons /thereby resulting in a sort of psychosensory numbness) and, on the other hand, to provide the nervous system with the substances it needs to regulate and manage the activation and the inhibition of the control modules. It is as if, without a precise knowledge of all the possible effects (especially the long-term ones), our body were provided with an "artificial module" that, through its interaction with the other "natural modules", interferes with the various biochemical processes. As mentioned several times throughout the book, we believe that semi-immortality can be achieved only by means of endogenous interventions (for instance, the identification and removal of the causes of the disorder), resorting to endogenous instruments (such as psychotropic drugs) only in cases of real and immediate danger related to our very survival. Therefore, one possible solution is the attempt to keep our body in balance, trying to avoid situations of prolonged stress and to enhance one's ability to manage those traumatic circumstances that, sooner or later, happen to all of us. As far as the problem of happiness is concerned, no conclusive solutions seem to be available yet. For instance a fact typically experienced at the phenomenological level is that any euphoric period is always followed by a depressive peak. We know that, most probably due to evolutionary reasons, our system does not allow us to maintan the level of euphoria or that of unhappiness. Therefore, the solution would be to preserve a sort of rising balance, limiting any emotional peak thanks to a greater willingness to control both types of emotion and an enhanced awareness of the damages stemming from certain situations. Notwithstanding the steps forward, the studies coonducted in recent years have not yet attained a detailed comprehension of the mechanisms that underlie this particular aspect of evolution, nevertheless the exhaustive understanding of this up and down process seems to be one of the keys to the possibility of a structurally stable happiness.

[133] *Drugs*. We have a largely negative view of the pursuit of happiness and pleasure through the use of drugs. While admitting that it may be hypothetically possible to use them in compliance with the primary criteria of truth and love towards the others, it would nevertheless clash with the principles of will and

self-control in virtually all cases. But even assuming the existence of a very restricted number of people able to keep their consumption under control, it would still conflict with the tendency not to resort to any tools that are external to our own system to achieve semi-immortality. In essence, we see the resort to drugs as a behaviour antithetical to semi-immortality, not only due to the high risks associated with their consumption, but, most of all, because they hinder the attainment of structural and stable happiness by compromising, often irreversibly, the endogenous capabilities of our mind-body system.

[134] Human history is studded with exceptional figures whose personal formation unfolded within a religious and spiritual context without nevertheless losing a grain of methodological rigour and philosophical incisiveness with respect to the Solution to the Game. An excellent example is John of Zebedee (6 B.C.) who is known as John the Apostle, author of the eponymous Gospel and of one of the most fascinating sacred texts, i.e. the Apocalypse. He is accounted to have been the only one among the disciples of Jesus of Nazareth who had remained alongside him throughout his preaching campaign until the end as well as the favourite apostle of his master (so much that Jesus put his mother in his care at the time of death). The Apocalypse, or Book of Revelation (from the Greek term it is named after), has the unique distinction of being the only prophetic book of the New Testament, deeply marked by an eschatological orientation (namely, it considers the fate of man and the whole universe). The greatness of this work essentially lies in the highly analogical and symbolic nature of the language used in it. In presenting the end of the world, namely Doomsday, John was ahead of the times, using such powerful symbols as to elicit the archetypes of his as well as future times: reformulating this in our language, he managed to tap into and activate the primary models of reference of human beings. We like to portray the figure of John of Zebedee through a paradigmatic phrase from his Gospel: "and ye shall know the truth, and the truth shall make you free". Another interesting example is Hildegard von Bingen (1098), also known as St.Hildegard; she was outstanding both for her writings and as an organizer of monastic life (up to the foundation of the monastery of Rupertsberg, over which she ruled as abbess). She was a musician, poetess, philosopher and above all a scientist, and she left us a conspicuous cultural heritage with works that cover nearly all fields of research: these works (among them we may mention the Liber Scivias", the "Liber Vitae Meritorum", the"Liber Divinorum Operum") partially stem from her experience of characte-

ristic visions (which were often accompanied by painful paralyses) and are written in prophetic tones. On the one hand, we are provided with a conception of nature encompassing both cosmological and naturalistic considerations, the traditional scientific culture and an innate ability to perceive the greatness of creation; on the other hand, the meaning of her visions is made explicit in a particularly innovative manner. In consideration of her position, it is a quite curious fact that Hildegard attached a great importance to human fertility, the value of sexuality and procreation. We now turn to Helena Petrovna Blavatsky (1831), who is distinguished for founding the so-called Theosophical Movement (by the term "theosophy", Helena referred to the body of wisdom accumulated and verified over time by generations of prophets). Neo-Platonic philosophy is identified as the divine wisdom to which man can attain only through mystical experience. According to theosophy, all religions are descended from one divine truth handed down by few initiates throughout history; what is needed is universal brotherhood, a healthy dose of ecleticism and the willingness to investigate the laws of nature and man's hidden abilities. The ultimate goal is to achieve absolute purity, the Nadir (similar to the Oriental concept of Nirvana): a particular meditative approach (i.e. cosmic meditation) coupled with a libertine lifestyle advocating merit and all forms of pleasure (including free love) and condemning any type of constraint and bond (such as marriage) lead to achieve a state of absolute purity (both at a moral and an intellectual level, in line with all respectable neo-Platonic approaches), thereby gaining enhanced understanding, analytical ability, intuition, empathy; this allows individuals to come into full contact with God, with the consequent possibility of comprehending the divine spirit in its ultimate essence as well as living a life of goodness. The concept of cosmic meditation encompasses the notion of benefit for the organism: meditation becomes a powerful antidote to stress and depression (theosophy maintains that one who reaches the Nadir carries in himself balance and sobriety in the highest degree). Finally, we come to one of the most prominent "spiritual" figures in history: Pavel Aleksandrovic Florenskij (1882). His reflection covered a number of fields (theology, aesthetics, philosophy of language, physics, mathematics, epistemology, engineering, etc...) producing a remarkable impact on each one of them. After graduating in mathematics with a thesis on spatial discontinuity, he took an interest in art, in particular he joined the symbolist movement: he was appointed head of the artistic heritage of the Holy Trinity Monastery, he collaborated to the draft of a technical encyclopedia, he read a course of lectures on "the analysis of spatiality in works of visual art" (of particular interest is his revisitation of the concept of space in the Divine Comedy by Dante Alighieri in the light of Einstein's theory of relativity); as a theologician, he engaged in the fairly successful attempt to realize the hoped-for union between Western philosophical culture and Christian theology. Florenskij's only "mistake" was to express the multiple forms of his genius within an unsuitable context: he was deemed socially dangerous by the totalitarian Soviet government and sentenced to a terrible period of imprisonment in the Siberian gulags. While the flame of science never extinguished within him (he is even said to have patented a special type of antifreeze liquid in that same period), he died near Leningrad at only fifty-five years of age.

[135] *Is there another dimension?* We know that the real is made up of the physical world and the world of information and that, according to our approach, these two dimensions are closely related, albeit not coinciding: we believe that any change in the physical world is associated with a corresponding variation in the world of information and vice versa. As far as the soul is concerned, the crucial question is the following: is there a third dimension besides those of the physical world and the world of information? At the present moment, we are not able to answer that question, nence we cannot aprioristically exclude a possible "dimension of the soul" (in which case, it would naturally be a part of the real. If it did actually exist, we would certainly expect it to exert some influence on the other two dimensions.. We believe we have never observed any direct effect, nevertheless, it may be useful to reflect on possible indirect ascendency. For instance, when we come sufficiently close to both the identification and reproduction of the organs of consciousness and, most importantly, will (whatever that means), we will be able to clarify whether a third dimension of the real is necessary or not. Perhaps, we will very "Buddhistically" discover that the third dimension does indeed exist, whereas there is no soul in an individual sense...

[136] *Free will.* Our life as rational and moral agents ultimately rests on the concept of choice and responsibility. To give an intuitive illustration of this point, let us consider the young Jack who consciously desire, plan and execute the murder of Ada: inasmuch as he has chosen to commit a crime and he has no extenuating circumstances to bring forward, understandably, the jury's verdict is "Guilty!". On the other hand, let us examine the case of John who has murdered Anna under the effect of drugs secretely administered to him by an evil scientist: after becoming aware of this fact, the jury declares him innocent because there was

nothing he could plausibly have done to avoid committing the crime in question. The moral of these stories is very simple: the attribution of moral praise or blame to an individual x for committing the action C appears to be based on the recognition of the fact that x could choose not to commit C; basically, Jack is sentenced while John is not because only the former could choose not to break the law, thus he alone is responsible for the crime and he has to pay for that. This intuitive framework of moral agents and this distinction between free choice and coercion have been increasingly called into question from several standpoints within the scientific and philosophical culture; "free will", which we traditionally, and perhaps a bit too naively, believe to be what distinguishes man from the rest of the world, seems to be a mystery that resists any satisfactory explanation. In essence, the problem is simple: the outstanding achievements of science (and in particular of physics) in explaining and predicting natural phenomena have somehow strengthened the "philosophical" conviction that human beings themselves are nothing moret han portions of nature clearly susceptible of scientific study. If this is true, the notion of freedom finds itself seriously threatened by the brute deterministic mechanicism of the material world: in fact, in all respects, the movements of men wouldn't be any freer than those of billiard balls rolling on a pool table in a predictable way. Two naturally arising questions are the following: we have to ask ourselves, on the one hand, to what extent our actions are free and, on the other hand, where the area of freedom might possibly be found. We shall comment on the latter, more practical question first and then turn to the former, more theoretical one. Assuming that the world is indeed entirely deterministic, this nevertheless does not imply that there are no significant differences between the billiard balls (as well as rocks and amoebae) and human beings. In fact, those systems we refer to as "human beings", unlike rocks and more complexly than amoebae, may be able to actively interact with the environment around them, perceiving the external world and its variations through the senses, planning adequate response strategies, modifying the unwanted characteristics with the tools at their disposal. If this is true, the mind takes the form of a box where inputs and outputs are connected: from perceptions to (more or less complex) connection options, from such options to the actions of the system in the environment. This basic scheme already presents us two possible hiding places for free will: the first within the module that, given perceptions, selects the connection, and the second within the module that, given the option, allows the action to be taken. Obviously, both modules are indispensable: without the first, we wouldnt't be able to understand why, given a certain input, the possible options are nearly always many (in other words, we would fail to explain the remarkable flexibility of the human cognitive systems); without the second, we could not comprehend the so-called phenomenon of "will", namely the process governing the transition from an option of conduct to the action itself (in other words, we would fail to explain the so very common weakness of will - *video meliora proboque, deteriora sequor*). If tyhe essence of the "phenomenology of choice" is truly mirrored by our reflections, whatever being the "seat of freedom" may mean to a module, then there is no reason why the same phenomenon could not also occur in other animals (at least those whose input-output path is of omparable complexity). But what does it mean that a module can give us freedom? A first answer lies in a strictly functional connotation, namely the individuality of the module itself: in fact, how could I be guaranteed possession of my own actions by a universal module? Under the assumption that the world is deterministic and hence so are the laws underlying the operation of the module, however, within a single existence, there seems to be no space for free will as commonly understood. In fact, while it is true that, since our actions are selected by our individual module, they somehow reflect us, nevertheless there remains the feeling that a profound part of the concept of freedom is lost. Let us think about the stories of Jack and John and the importance of concepts such as responsibility and the ability to act otherwise: even though many philosophers, i.e. the so-called "compatibilists, from David Hume to Daniel Dennett, have tried to show that free will can be reconciled with a strictly deterministic view, there remain doubts about this line of thought. The assumption that the world is partially non-deterministic leads to suggestively different scenarios. Should the only non-deterministic laws ultimately turn out to be physical (as suggested by certain interpretations of quantum mechanics, which are, in our opinion, a bit too far-fetched), for us the situation wouldn't be any better: if the only sense we can give to non-determinism is randomness, then random fluctuations of the microcosm may have something to do with what happens to us, but certainly not with what we do. On the other hand, should the non-determinism of physical reality turn out to be only a surface phenomenon, the perspectives would be different. In the book mentioned the possibility that something like the "soul" might exist; well, we all have a strong feeling that we are free and this may indeed be an argument in support of this hypothesis. The soul would exist in a dimension of reality other than the physical (and informational) one and there it would express itself non-deterministically, thereby explaining what occurs at the physical level which is the only one we currently have access to. At the present state of things, there seem to be no particular reasons beyond those stated in the book to bet on the existence of a soul with individual or, conversely, universal characteristics.

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14. Aesthetics

The concept of *Aesthetics,* and thus of beautiful and ugly, basically encompasses the notion of verification of the results achieved. If the outcome is beautiful, then we have moved closer to the solution, if it is ugly, then we have veered away. As far as the Game is concerned, ethics provides the logical mind with indications about the paths that should be followed, while *Aesthetics* supplies the analogical mind with the cues to evaluate the validity of the results that have been attained. In comparing two functionally equivalent results, it becomes apparent that the more beautiful one will also be the more useful one inasmuch as it will enable us to approach the Solution at a faster pace. Thus, it is in this context that it is correct to speak of beautiful and ugly, and it is only in this context that we will proceed.

But how can we discern whether a result is beautiful or ugly?Just as it is the case with the concepts of good and evil, also the answer to this question is very complex and it is not possible to oversimplify the issue. When is a poem beautiful? When is a painting, or a musical piece, or a mathematical formula, or a geometric theorem, beautiful? And how about a healthy person with respect to a sick one or a place to live? The ethics of semi-immortality rests on a relatively simple deductive pattern: first truth, then love, then happiness and then again, all the rest. Inasmuch as it addresses the analogical mind, the *Aesthetics* of semi-immortality cannot follow a deductive path, rather, it will necessarily be circular. The beautiful is composed of the concurrent presence of a certain number of characteristics: the beautiful is harmony and completeness. The beautiful deprived of harmony and completeness becomes less beautiful

Fig. 14.1. A few innate concepts related to *Aesthetics*.

or even ugly. Therefore, harmony and completeness are the primary traits of the beautiful. Symmetrically, these two components are balanced by originality and essentiality. A genius is one who is able to properly amalgamate these four components and to express them, thanks to technique, by means of a symbolic language that is as universal as possible.

Even though *Aesthetics*, just like ethics, is a transversal concept to any action of ours, it nevertheless falls into the "cold" zone of philosophy. People are very unlikely to come to the point of killing each other to determine what is beautiful and what is ugly. From an evolutionary standpoint, it would appear that the judgement on the outcome of an action is attached less importance than the causes that led to the action itself. Or perhaps, the circularity of the concept makes it more complicated to understand and hence it is less prone to lend itself to be the object of dogmatic drifts. It is far from easy to have a conscious approach to *Aesthetics*, inasmuch as we often experience it only in terms of sensory perceptions. Beyond any doubt, sensory intensity is a valuable evolutionary aid to judgement, but it serves the only purpose of catching our attention and it is not useful in discriminating between what is beautiful and what is ugly. Furthermore, the language employed is an intrinsic component of *Aesthetics*: a mathematical formula cannot be appreciated in its entirety without knowing the meaning of the symbols. Listening to a song in some unknown (or poorly known) language, of course, limits the effectiveness of communication. The interesting thing is that we can nevertheless take delight in artistic expressions that we do not wholly understand. As cleverly pointed out by Marshall McLuhan, also “the medium is the message”[137].

We have all along regarded the understanding of the *Aesthetics* as a milestone in the path towards semi-immortality. In fact, the first research carried out by our Laboratory was concerned with language and, in particular, with what might be considered as beautiful or ugly in literature. The work of many researchers, from Immanuel Kant to Harold Bloom, have undoubtedly helped us in the difficult art of separating the genius from the “noise”. A thorough comprehension of the essence of the *Aesthetics* implies a significant support to one's sense of direction, in any field of human activity[138]. A musical piece, a computer program, a mathematical proof, they all follow the same rules of beauty. The so-called geniuses are nothing but the best players, namely those who instinctively “feel” what is beautiful and possess the necessary technical expertise to implement it. We expect *Aesthetics* to be the domain where it will be possible to measure the progress of artificial intelligence. When the machines are capable of autonomously producing high-level artistic expressions, we will not have to be concerned with or scared of this, rather, we will simply have to rejoice over it because it will mean that semi.immortality is really close.

14.1 The formation of aesthetic judgment

Now, let us examine those characteristics that, according to our approach, should allow us to get our bearings in our own aesthetic judgment. Let us begin from Harmony. The concept of harmony basically encompasses the notion of equilibrium between the parts. This equilibrium appears according to certain proportions, some of which our mind perceives as beautiful, probably because they somehow adhere to the ultimate laws. Among the most studied examples of harmonious proportions, we may mention: uniformity, symmetry and progression. Uniformity means that the parts of the whole tend to have a similar importance. Symmetry implies that if there exists a component that weighs more in a given area, then we expect that there also exists a corresponding one in a somewhat opposite area. Progression refers to our expecting an element to possibly be the sum of all those that have preceded it (such as in the logarithmic spiral and the golden section[139]). In the early 1200's Leonardo Fibonacci was the first ever to articulate such concept in mathematical terms. In a sense, Harmony is the art of assigning each element the proper weight, both in relation to the other elements and with respect to the whole.

The concept of Completeness is closely linked to the concept of Harmony and it fundamentally encompasses the notion of attention for all the parts. Such attention mainly materializes in the care that is properly devoted to every single element, regardless of the extent of difficulty or required effort. The overall perception of beauty also depends on the tiniest details. The more we approach the beautiful, the more bothered our mind will be by imperfections: a stimulating job with a few defects may upset us more than an insignificant one. As far as the *Aesthetics* of semi-immortality is concerned, Completeness also possesses a self-referential value. In fact, if we need to be able to move truly close to the beautiful, all the elements con-

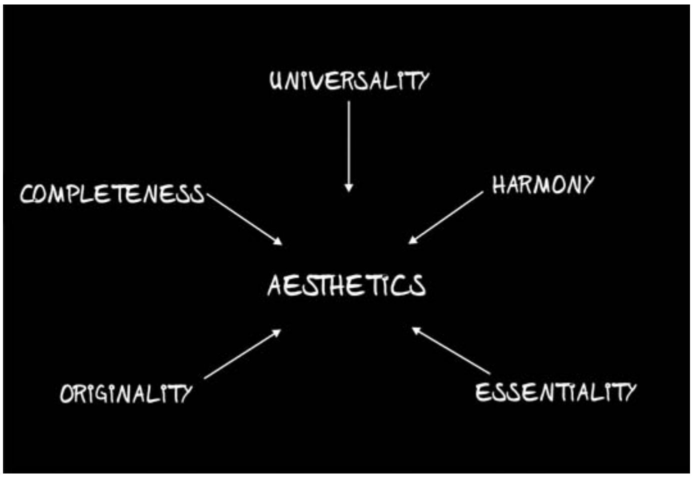

Fig. 14.2. The formation of the aesthetic judgment.

tributing to its perception must be present. For instance, a very original, yet not armonic, outcome might perhaps intrigue us, but it will generally be bound to be less enduring than an outcome that exhibits both characteristics of originality and harmony.

The concept of Essentiality basically encompasses the notion of efficiency, namely the minimum amount of energy required to perform a given task. Essentiality is not synonym with simplification, but, conversely, it is the key to be able to manage any possible complexities. Essentiality allows to save pointless effort and it ensures stability over time. In a sense, it is directly related to evolution. It is a force that operates in antithesis to Completeness: therefore, a genius is one who succeeds in being essential and complete at the same time. We might state that Essentiality is the most "logical" component of *Aesthetics*.

The concept of Originality essentially encompasses the notion of content of novelty with respect to previous solutions. Originality is the feature that most captures our attention and, as far as the Solution to the Game is concerned, it is this characteristic that enables us to experiment with new paths. Originality refers to the ability to approach a problem in an unconventional manner and, among all the characteristics of *Aesthetics*, it manifests itself as the most immediate and the most closely related to our senses. The main risk associated with Originality is sterility: in fact, the greatest part of original ideas turns out to be less useful than well-established ones. Nonetheless, those few that emerge as "good ideas" automatically make all previous ones obsolete: this is why most people instinctively love their own novelties, but tend to be suspicious of those of the others. When dismantled of its facet of dangerousness, Originality is generally a pleasant and catalyzing characteristic; on the other hand, when its use is excessive and not balanced by the other characteristics, then it rapidly becomes nonsensical and therefore even tedious. The action of this force is antithetical to harmony: thus, a genius is one who succeeds in being original and harmonious at the same time. We might argue that Originality is the most "analogical" component of *Aesthetics*.

The concept of Universality basically encompasses the notion of comprehensibility. Whatever the means of expression, the models of reference that are activated must be as homogeneous and shared as possible, regardless of the culture of the people involved. If the beautiful is truly beautiful, then it will be perceived as such by anyone. This implies being able to develop those skills that enable one to get as close as possible to the essence of the beautiful as it is perceived by our mind. As examples of visual techniques that tend to adopt an expressive language as universal as possible we might cite the use of perspective in the path towards the reproduction of reality by Andrea Mantegna, rather than the links between the microcosm and the macrocosm of Benoît Mandelbrot' fractal geometry, or the surrealist symbolism of Salvator Dalì. Universality also allows us to realize great works, by means of supporting techniques, and to effectively add undertones of meaning that could not be attained otherwise. We might assert that Universality is the most "realizational" component of *Aesthetics*.

Now that we have outlined the basics of the formation of the aesthetic judgement, we can engage in an analytical discussion of what precisely happens within our mind. When we look at a painting, or we listen to a musical piece, or we read a book, a certain number of models of reference are activated within our mind. Some of the models of reference will be directly related to the sense, such as the colours used in a painting, whereas for others, the connection will be more indirect, for instance, the scene represented in the painting itself. These models of reference will in turn trigger other models of reference in a chain of reactions which will be different for each person. Such chain of reactions will ultimately determine our overall perception, just like in any situation of everyday life. When the intensity of perception exceeds a certain threshold, we tend to pause over such perception as it has aroused our curiosity and, if the perception is pleasant, we try to protract it or repeat it. An "ordinary" sunset will catch our attention far less than a spectacular sunset with all the shades of pink and turquoise and the constantly changing intensity of sunlight as the clouds filter the reys casted on the waves of a stormy sea that is being looked at from a pier[140].

Anything that manages to activate a sequence of pleasing models of reference within us, as a first approximation, can be considered as "beutiful". However, this is only the first step in the various shades of beautiful. The more the senses that are involved, the stronger the intensity of the perception and the higher we climb in the scale of the beautiful[141]. As we have seen, according to our approach, man is endowed also with the senses of language and consciousness. Therefore, we expect these two senses to play an important role in the scale of the beautiful inasmuch as, on average, they are associated with the highest levels of intensity. The one-love experience is beautiful because it provides us with what is perhaps our only chance to involve practically all the senses. It is beautiful, but it may easily turns into ugly because, as it is well-understood, the associate intensity reaches its highest levels and then even a minimal alteration in the aesthetic rules, such as those of harmony, is enough to generate suffering.

It is difficult to calculate the precise number of models of reference that are triggered by reading a book or watching a movie. Notwithstanding that this amount changes from person to person, however, we deem it reasonable to suppose that such number is particularly large. And, forasmuch as an emotion is potentially associated with each model of reference, it seems fairly clear that the overall perception of any event is extremely complex. As to the reduction in complexity, the innate models of reference come into play. The abilty of an artist is precisely measured as the capability of evoking the innate models of reference without excessively stimulating the acquired ones, or, alternatively, of preliminarily providing us with the instructions to share the acquired models of reference. This is the essence of universality. For instance, we believe that Cubism cannot be appreciated in its essence without the models of reference of Impressionism: it is arduous to view most of the cubist works as "beautiful" without employing the models of reference of the antecedent art[142].

14.2 Artificial *Aesthetics*

When we move closer to the construction of artificial-Selves endowed with the analogical mind of Leonardo da Vinci, with the logical mind of Isaac Newton and with the realizational mind of Wernher von Braun we will have the support of extremely powerful tools to attain semi-immortality. It is our conviction that, at that point of our history, the real danger will not reside in the ethical framework of reference, but rather in the *Aesthetics*. And more than this: we believe that the risk will not come from the machines, bur rather from men. In other words, we don't expect us human beings ever to be supplanted by our artificial offspring, whereas we think that the reactions of men in face of a machine that is capable of painting a fine picture, of writing a passionate and telling poem or of speaking in a convincing and metaphorical manner, cannot be fully predictable and controllable. The beautiful is an extremely powerful key to access our mind and it is dangerously uncomplicated to attribute any drifts to it, be them metaphysical, divine or devilish. Perhaps, we are over-concerning ourselves because the whole process will be smooth and natural, just like it has been the case with the advent of many other technological innovations, nevertheless, we believe that this crucial evolution will be very difficult to handle without extremisims in either direction. And the main field of tumult and confrontation will, indirectly, be *Aesthetics* indeed. This issue should be tackled right from the start.

If it is true that we will need to be vigilant to avoid the ethical/logical trap of self-assertion devoid of a state of harmony with the universe, it is also true that we will have to be even more alert to escape the aesthetic/analogical trap of metaphysical drifts. We are aware that within man there exist violent and destructive models of reference that may be triggered by the political or religious leader on duty without much effort. Our real preoccupation is that a truly intelligent technology might easily become the symbolic pretext for a demon to destroy or a new deity to follow. It is a demanding task for man to remain neutral with respect to evolution, he has to satisfy his natural instinct to take sides and, if he feels threatened, he does not hesitate to turn violent. The crucial question is that the threat is nearly always an invention (be it voluntary or involuntary) of the leaders as an effective means to maintain and strengthen their power. At this point the non-truths (both the conscious and unconscious ones) become the primary means through which the threat is amplified, and thus violence inevitably appears as one of the options. And there comes death, which is just as useless as it is stupid because its foundations are non-truths. What can be done then to minimize this kind of risk?

First and foremost, truth and transparency. We believe that science, technology and the related economy that will accompany us along this path will have to keep no "secrets". The procedure enabling a machine to understand a poem or to compose a painting, will have to be available to anyone who might have an interest in examining it. The same companies that will operate in the economy of semi-immortality will have to be completely transparent. In other words, when they are ready, the source code of the artificial-Selves, rather than the techniques of genetic analysis, will have to be available to everyone. But this is not enough. The same dynamics of the underlying income-generation will have to become gradually transparent: there is nothing wrong with creating wealth and prosperity. Again in a perspective of semi-immortality, evil lies in generating a profit from conscious non-truths. Our belief is that only the tendentially utmost transparency can ensure the smooth flow of this technological transition and the indispensable cooperation of the best minds of the planet. There will be nothing divine nor diabolic in a machine that is able to write an enjoyable novel. It will merely be a sequence of models of reference, applied in the right order and with the adequate degree of complexity. Just like for human beings. Let us prove, verify and accept this and most of the dangers will be ineffectual.

In our opinion, the second guideline that must be followed to circumvent the aesthetical/analogical Trap is the progressive removal of collective phenomena. It will be the single individuals who will attain semi-immortality and it will be the single individuals who will make it possible. When a sufficiently precise understanding of the fundamental models of reference of the human mind is achieved, such knowledge will have to be spread as widely as possible. Each person must be enabled to "detect" and "comprehend" those meachanisms that affect ideas, instincts, and behaviours. Regardless of one's religious and political beliefs, the semi-immortal man will need to have a clear understanding of the mechanisms that underlie the functioning of one's own mind and of how a person's mind is prone to be influenced by the events and, most of all, by other people's mind. With respect to the current situation, "to have a clear understanding" does not mean "to comprehend it vaguely", but rather "to understand it in a deterministic way". As highlighted by many researchers, most notably José Ortega y Gasset, abstract reasoning fails to solve the dangers arising from the aggregations of men into groups or classes because a too high degree of emotionlism is involved. Only practical demonstrations and the following disclosures might enable us to hope for the end of the mass-man phenomenon, which, from an evolutionary point of view, has probably proved useful so far (just like falsehood and violence), but which we deem incompatible with semi-immortality.

14.3 Therapeutic characteristics of *Aesthetics*

Physical beauty is admired and desired in all cultures, it is a "perceptual fascination" encompassing the laws of harmony, appearance and form, both internal and external. As it should be clear from the previous paragraphs, we think that a substantial part of the commonsense beliefs about aesthetics are simply wrong, most notably the argument that "beauty lies in the eye of the beholder", therefore a totally subjective fact. This belief seems to be contradicted by most of the reearches on the subject. If a large number of people are presented with a series of photos depicting faces and we ask them to evaluate the degree of beauty of each face, we find a remarkable agreement in their opinions about what are beautiful and what are ugly. If the same photos are shown to children, we observe that their judgements coincide with that of the adults. The aesthetic choice is related to instinct, an inner perception that responds to inner satisfaction. For instance, a symmetrical development is one of the most convincing signs of "health" as it testifies the absence of past traumas and of future pathological inclinations. The symmetry of the two brains results in the harmony of both the creative and the logical thought and the effects it produces on both the body and the actions (and thus towards the others) exhibit a high degree of seductiveness (attraction).

The relevance of aesthetics in treatment is a consequence. When a patient is asymmetric (therefore, sick), he tends to be ugly, he fails to accept himself and he doesn't feel accepted by society either. A body that heals from diseases and a mind that becomes harmonious, coherent, fertile, lead to beauty: the eyes widen, the forehead looks more open, the smile is more pronounced, the skin tone is brighter and the body regains the proportions it had lost. Research in this field is increasingly showing that another truth exists: happy people are healthier and more good-looking than the unhappy ones. Having serene/consistent thoughts for most of the time causes biochemical changes in the brain which, in turn, have profoundly beneficial effects on the physiology of the body, and hence on the aesthetics. Every individual undoubtedly needs a point of comparison, thus we believe that a "beautiful" therapist may be more effective than an "ugly" therapist, also because this facilitates the identification of the equilibrium, starting from who is treating the patient. Intelligence, knowledge, balance, harmony are the ingredients to become, or remain beautiful, to preserve what nature has endowed us with at birth, thereby keeping ourselves unchanged over time.

We often confuse being beautiful with becoming so through a series of artifices that promise a parody of semi-immortality by means of a "surgical cut", but rather hamper the work of our mind engaged in the pursuit of an ever-young appearance. External interventions risk to undermine our mind's ability, which is coupled with will power, to regenerate and self-regenerate. We do not know whether our liver or spleen are beautiful or not, but, at the same time, we do know that, nearly always, they possess the ability to self-regenerate by creating a self-referential system that is assigned the task of cellular regeneration. All of our tissues, from the most internal to the most external ones, are a product of our mind with its contents, every wrinkle is the symbol of a particular experience, or a moment of suffering, or an act of will. Our whole being is a river that flows under the action of energy: any modification of such flow in the skin and blood alters its trajectory.

By surrendering to external, artificial aids, we are bound to encounter two kinds of problems: on the one hand, we cease to struggle to make those changes on ourselves which are essential to our own individual psychophysical development; on the other hand, we interrupt the activity of those cells of ours that are operating to adapt the system towards that particular process that is called "the elaboration of personal experiences for self-regenerating purposes". Tumors (physical) as well as traumas (psychic) must be processed by the mind in order to regenerate both psychic and physical tissues. The metamorphosis that is realized through suffering (pain) and the solution that one manages to find, lead the individual to a renewed, transformed, true beauty. The struggle for semi-immortality undoubtedly passes through aesthetics and we are profoundly aware of the importance of fighting alongside the patient to regain a lost "beauty" (recognition of self). A disease seems to sweep everything away like a tsunami, it just comes and overwhelms, but the sand remains. Then, the water resumes its rhythm, nature, albeit devastated, continues its cycle, the houses are no longer there, but the sea and its colours endure. Those who return to those places cannot find what had been constructed, but they rediscover the beauty of unchanged nature. The tumor comes, overwhelms and sweeps away, but the essence of the person, after being cleansed of fears and anguish and reprogrammed to come back to life, regains its "real" beauty and the photos of these persons can prove that. It is a sort of training to semi-immortality. There is so much we can understand, or, more precisely, "perceive", from the accurate examination of a photo of ours!

What is to be done with the preservation of beauty "in the sense of youth" for those who seem to live without traumas? We believe that a lifestyle characterized by balance, serenity, truth, and by a will leading the individual towards those expressed or unexpressed capacities (both known and yet to discover), does slow cellular oxidation. The brain must continue to give instructions to the nervous system through the release of endorphins, noradrenaline, adrenaline and by means of the endocrine system as a whole. A surgical intervention leads the individual to a state of "biological mental relaxation", since, as a matter of fact, surgery has replaced the mind. When "waking up" after 6/8 months, the mind finds it effortful to "understand" what happened. On the contrary, the individual is heading for premature aging resulting from a "cosmetic surgery addiction". And you are left with no peace of mind. By its very nature, the effectiveness of an artificial beauty is nothing like that of natural beauty, inasmuch as only the mind knows best "the rules of the cellular game". From the standpoint of semi-immortality, surgery, be it aesthetic or general, should be the last resort after all the other types of intervention have proved fruitless.

[137] *Medium is message*. Already Plato had argued that Reality is for a large part constituted of *techne*. Transporting this typically Greek concept to today's world, we can state that he was totally right. The technologicle vehicle, i.e. the *medium*, pervades our society as it seems to be the only real point of contact between the system man and the environment it is immersed into. Therefore, we can come to assert that its effects on society are remarkably substantial and pervasive, regardless of the specific message conveyed: the mental structure of individuals thus is strongly influenced by the type of technology employed (the *medium* conveys a message first and foremost because it refers to its own existence, namely it has the property of being self-referential). Marshall McLuhan was the first intellectual to point out the close connection among mind, senses and media: in a sense, it is the *medium* itself to decide what message to convey. His is indeed the momentous statement "*medium is message*": the sensory sub-modalities that characterize the different media constitute, a priori, the meaning they communicate. In the area of purely logical and aesthetic thought, Ludwig Wittgenstein had his say: before being a logical representation (image), every representation is a a presentation of its own formal and material specificity; being a transcendental interface, every logical form cannot prescind from the specific type of empirical media in which it manifests itself. In short, Wittgenstein argued that each medium (image) can refer to something else only inasmuch as it refers to itself. Due to the identity of medium and message, which are "aesthetically inseparable", the work of art cannot be further interfaced: any modification of the *medium*, inevitably implies an alteration of the message it carries. Another area of reaserch which is affected by the "*medium- is- message*"problem is psychocybernetics (whose main objective is to use the concepts of classical cybernetics in such a way as to enable the individual to enhance the organization and the control of his mind).These studies inevitably conceive counsciousness as technology and confide in the platonic revelation about the inextricable relationship between psyche and *techne*. Within the purely medical and therapeutic domain, there arose a technique known as neuro-linguistic programming (NLP), mainly thanks to the contribution of the school of Palo Alto: change began to be analyzed from a systemic perspective according to which every single data item is considered only in its interaction with the context it refers to. NLP researches try to prove that our mental representations of the events are characterized by specific parameters which significantly contribute to the meaning that each of us tends to assign to our experiences, regardless of the content of the representation. There seems to be evidence

supporting the fact that the anxiety related to a particular negative experience depends on how the individual remebers such event: to overcome the problem it is thus necessary to act not so much on the content, i.e. the message, but rather on the characteristics of the image, i.e. the *medium*, with which the traumatic experience has been "saved" in our mind.

[138] *Neuroaesthetics*. It is no coincidence that in recent years the most stimulating arguments in the domain of aesthetics have been formulated by scientists of the human brain and behaviour. It is now a verified fact that both imagination and perception rest on physiological bases that are common to all human beings and vision seems to be an active process, whereby the retina would act as a filter of the signals between the continuous flow of reality and our brain. When we have the same object in front of us, light signals are converted into electrical impulses that activate specialized areas in image perception and processing; the mechanism of image decompositions into its essential components (i.e. color, shape, space, face, motion, etc...) and image processing is the same for everyone. Neuroaesthetics is the discipline concerned with the investigation of the various artistic expressions from a neurobiological perspective (i.e. analyzing what neuronal configurations and functional areas are involved in the subjective experience of beauty), with the aim of developing a satisfactory aesthetic theory (in an objective, or at least universal, perspective). We now know that one of the primary functions of the brain is to know the world and the main way to do this is to search for regularities in what we experience as the reality surrounding us. In consideration of the continuous mutability of reality and, in spite of this, our ability to recognize objects and situations, it seems legitimate to hypothesize that there are in the brain some mechanisms that are able to extract constant and similar information from what appears around us (this law is referred to as the "law of constancy"). When any deviation from this law occurs (for instance, if there is a blue apple in front of us), we know that our brain tends to respond by loading the image with a higher emotional charge in order to firm up the new and unusual acquired model of reference. Another operation carried out by the brain is that of abstraction, which is aimed at selecting universal concepts applicable to numerous individuals (lines, points, etc...). when the brain identifies a given shape, it does so by applying to it those among its internal models which approach it the most (the least distant in mathematical terms). Immanuel Kant was among the first to speculate that the principles of beauty are universal and based on precise physiological mechanisms within our mind. The

results of recent studies appear to prove him right: there seems to be a single brain structure responsible for the determination of our aesthetic judgment in front of a work of art. The more intense the activity of this area, the greater the appreciation of the work. Of particular interest is the phenomenon of "shared understanding" which occurs in the presence of certain artistic expressions (suffice to think about the shared sense of emotion which is usurally felt by people in front of works such as the Pietà of Michelangelo Buonarroti). These hypotheses found further confirmation in the recent discovery of the so-called mirror neurons: it was found that monkeys exhibit the same neuronal response both when they perform a certain action themselves and when they observe the same action performed by others. Obviously, it seems reasonable to hypothesize the existence of the same system in humans. In the case of a work of art, certain representations generate specific neuronal responses as if it were the observer to execute them. Once the (biologically) universal nature of aesthetics is accepted, an open question remains: if it is true that the physiological foundations are common to all men, then how can we explain the great variability in the reactions of people to a same work? Also in this context, a possible approach may be to resort to the models of reference: the full appreciation and understanding of a work of art requires the stimulation of a certain number of models of reference within our mind. Those who possess models of reference sufficient to understand the work will find it more "beautiful" than those who do not.

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[139] *The golden section and the logarithmic spiral.* Leonardo Fibonacci provided us with an exceptional tool of knowledge, namely a particular sequence of integers, which starts from the pair of numbers " 1 , 1 " and exhibits the following peculiar characteristic: each number in the sequence is obtained by taking the sum of the previous two numbers, except for the first two terms (1, 1, 2, 3, 5, 8, 13, 21,...). The formal definition is the following:: $a(n+1) = a(n) + a(n-1)$, with n greater than 2. As we already know, functions that are defined in terms of themselves are referred to as "recursive". Furthermore, we know that there exists a specific irrational numerical value (approximately 1,618033988),which is

related to the Fibonacci: the golden ratio or "golden section". This value is obtained by taking the ratio of successive terms in the series for a very large value of n (the limit as n tends to infinity is equal to a(n+1)/n); in other words, the ratio of successive terms in the series tends to the Golden Ratio. This ratio can be expressed in mathematical terms as (1 + sqr(5)) /2. The Golden Ratio can also be defined in analogical-spatial terms: if an intermediate point is set on a segment so as to divide the whole segment into unequal parts, such parts will be in the golden ratio if the ratio of the shorter part to the longer part is exactly the same ratio as the longer part is to the whole segment. Another interesting relationship is that between the Fibonacci sequence and the "logarithmic spiral": if we construct a series of squares next to each other, where the side of each square is equal to the sum of the sides of the previous two, then it will be sufficient to draw a quarter of a circle in each square to let the logarithmic spiral emerge (it is able to form a line from the center, which is increased by a factor equal to the Golden Section in each square). The main feature of this spiral is closely related to the concept of fractals by Benoît Mandelbrot: it continues indefinitely both inwards and outwards, and it constantly maintains its shape regardless of any variation in the scale and the observation point. It is far from uncommon to find the formal patterns we have just described in the physical world. The golden proportion, for instance, wasextensively used by the ancient Greeks in their architectural constructions, by the Egyptians in building the pyramids, as well as in Reneissance paintings (Leonardo da Vinci called it the "divine proportion", namely the aesthetically most pleasing relationship between the lengths of the parts of the human body). The Fibonacci sequence appears in some musical works of Johann Sebastian Bach, Ludwig van Beethoven, Franz Schubert and Wolfgang Amadeus Mozart, in the biological development of some species, in the arrangement of petals and seeds and, in its acceptation of logarithmic spiral, it is clearly noticeable in the shell of the mollusc *Nautilus*. As it is always the case when we are faced with the great fundamental laws, we realize that the dividing line between micro and macro, which is so clear to our everyday limited perceptions, vanishes out.

[140] On the other hand, if we lived in an environment where such "exceptional" sunset is just the norm, after a certain number of repetitions, we would find ourselves far more charmed by the view of a perfect yellow circle in a clear and homogenous blue sky. We have already analysed that originality is the most immediate component intervening in the process of formation of aesthetic

judgement. We have always been impressed by an example in particular. In Milan there is one of the most characteristic and probably one of the most finest construction in the world, i.e. the Duomo. Up to a certain age, we were so accustomed to its presence that we can say that we used to ignore it altogether. It was only when we began to travel, know and make comparisons that one day we paused to look at it with different eyes and we started to appreciate its stunning excellence. Today, the windows of our offices give onto the spires of the Duomo and every time we gaze at it we are totally fascinated by such beauty.

[141] The magnitude of perception depends on the number of models of reference activated and the emotional weight attached to them. A painting, a book, or a musical piece usually leave more room to the sense of consciusness as compared to a movie or a play and, as we know, consciusness is the sense whose respective weight is significantly larger. All things considered, we may venture to say that a book is generally better than a movie but a good movie is better than a good book. In this perspective, we consider sexual activity as one of the main forms of art: it is possible to employ virtually all the senses and if the mise-en-scène involves one's own one-love, then the emotional and consciential amplification is maximum.

[142] Further complicating the analysis is the fact that a significant number of people seem to have a preference for what they do not understand. This particular characteristic has always intrigued us and, most probably, the explanation to this attitude is to be found in the presence in humans of specific models of reference responsible for preserving one's perception of oneself. Such models presumably belong to the same category of those models of reference that explain why, against all evidence, men tend to complain about earning a lower income or about being less fortunate than someone else, but they are unlikely to grumble about being less intelligent or skilled. All things considered, as a famous Spanish proverb goes, “intelligence is perhaps the only wealth that was distributed evenly, in fact no one complains about having less than others”.

15. Society

The concept of *Society* basically encompasses the concept of coexistence of multiple systems. The fundamental problem for any societal form may be formulated as follows: "how should the coexistence of different systems be organized in a situation of limited resources?". The *Society* of semi-immortality will necessarily have to derive its underlying principles from ethics and its achievements will have to be guided by aesthetics. We are approaching the time when technological innovations will significantly reduce the gap between ideal and implementation. Therefore, where truth underlies everything and it is to be pursued no matter what. Non-truths are to be progressively eliminated, starting from the conscious ones.

From an evolutionary standpoint, in a reward-punishment perspective, a repeated, conscious non-truth will have to be given the harshest punishment. The maximum punishment should, however, take into account only the concept of defense, discarding the concept of offence, without judgment of merit. We all have made mistakes and will probably do so again, what is crucial is that we have to protect ourselves as much as possible from those behaviours that, either directly or indirectly, move us away from the Solution to the Game, thereby pushing us closer to death. Today, no one can claim to know the absolute truth, nor guarantee to be on the right track. Everyone can just try to make one's own information and intelligence available to the endeavor. Those who are utterly certain of being right, cannot be intelligent, or, at least, have access to only a limited amount of information, hence, their chances of being truly right are close to zero. And if this certainty is rooted in non-truth, non-love or non-happiness, then even without knowing what is the right way, we will definitely be able to recognize the wrong paths with a sufficient degree of reliability. Also in this case, aesthetics will provide us with the yardstick to evaluate results. An extermination camp is ugly. The cries of a person being tortured are ugly. People who die of hunger are ugly. A fanatic who blows himself up in a crowd is ugly. Just like a crowd out of control destroying everything on its way is ugly. The concept of *Society* takes us back to a "hot" area of philosophy, inasmuch as the organization of *Society* is undoubtedly linked to the distribution of resources. This issue has led man (and, more generally, any living form) to develop a considerable number of related models of reference each assigned with the respective emotional weight. And it comes as no surprise that some of these emotional weights are particularly high, since the models of reference involved here are related to the primary instincts of survival and reproduction. Many researchers have cleverly dealt with this issue and from several different points of view, among them we may mention Sun Tzu, Desmond Morris , Niccolò Machiavelli, Milton Friedman and Karl Popper.

It is our conviction that the technological evolution of the coming years is bound to reshape the concept of *Society* and the crucial step will be the gradual eclipse of the political concept of delegation and representation. Different forms of *Society* will arise and the individuals will be able to choose to what they will belong, thereby committing themselves to comply with the relevant set of rules. A systematic non-compliance, if conscious, will be grounds for the termination of membership to the *Society*, whereas, unconscious non-compliance will be returned to compliance thanks to the intervention of the other people. We believe that the *Society* of semi-immortality must be based on voluntary agreements among individuals who adhere to a general project with few fundamental rules. Territorial considerations will be emptied of a considerable part of their

Fig. 15.1. A few innate concepts related to *Society*.

meaning. Today, this type of *Society* might already exist in substantial harmony within any Western nation and we think it does represent its natural evolution.

The attainment of semi-immortality will require the contribution and the cooperation of a remarkable number of individuals, at every level. Those people, who feel like "they are born for this", will directly take part in the process, others will wait to benefit from the results. Other again will try to oppose the change, following patterns of behaviour from which the *Society* of semi-immortality will seek to protect itself. In our opinion, once the mechanism is triggered, it will become unstoppable and all the problems will progressively be overcome. It will be vital to avoid any form of radicalization not to let ourselves be fooled by false shortcuts: if the objective were achieved to the detriment of someone or something, the path would have to be modified. From a structural point of view, a (by the way, temporary) non-improvement of some system might be acceptable, but no worsening will be tolerable.

Technological development will allow us to construct the adequate instruments to let the *Society* of semi-immortality rise and evolve. Up to now, a major problem encountered by any form of *Society* has been that the burden of ensuring compliance has necessarily fallen on men. A powerful and just king might not remain so over time. As it is well understood, the existence of a perfectly fair and impartial judge is simply impossible, both due to objective reasons of knowledge and to subjective reasons of personal experience. The concept of delegation which is inherent in the current form of democracy results in a large number of distortions and injustices. From the standpoint of semi-immortality, the so called Western system of social order cannot but be regarded as the "lesser of the evils" among the currently available options. We may say that the path towards semi-immortality starts from becoming aware that the room for improvement of our mind, our body and the social organization is enormous and it will progressively be open to the contributions of whoever will be interested.

As we address the issue of social organization, we must clearly establish the context in which we are proceeding. The opinions expressed herein are not so much descriptive as prescriptive, and, in part, predictive. This book aims at fostering the progressive advance towards the Solution to the Game and it builds on the firm belief that it will bring about the attainment of semi-immortality. This is coupled with the reasonable conviction that the Solution to the Game is indeed the ultimate goal of human life and, more generally, the ultimate meaning of the existence of the Universe itself. Today we have access to a huge body of knowledge, we know fairly well how Reality operates and we've been starting to understand the functioning of our Mind. The question is: based on the information available, what is the best strategy to extend human life indefinitely? We believe that this book offers an intelligent and comprehensive answer to this question. It is an intelligent answer because it recognizes reality for what it is, without prejudice; it is a comprehensive answer since it discusses all the instruments that will be necessary to achieve the goal. As we were explaining, this book is not merely a sort of book of instructions, but rather it also has a predictive value. Such predictive value stems from the conviction that the Game (however we may call it) does exist independently of our ability to deal with it and that if the current generations fail to solve it, the future generations will succeed. The path is unclear: we do not know whether we will be able to cover such distance personally, nevertheless we deem it highly probable that, sooner or later, someone will accomplish it.

As already stated in the introduction, we are convinced that, if the issues are tackled with rigor, honesty and sufficient intelligence, we all come to, more or less, the same conclusions. It is true that the existence, or not, of a "dimension of the soul" (whatever that means) is a substantive question, but, since, at the present time, no one can be sure of the answer, in neither sense, we believe that the advocates of the two theses might easily cooperate for the Solution to the Game (every one will give it whatever name one pleases). It will be sufficient that everyone agrees to adopt truth as the primary value. Our opinion is that, in nearly the totality of cases, disputes arise merely due to semantic reasons, or because different mental domains or levels come to confront each other. Once the field is, as much as possible, cleared of the ambiguities of meaning and misunderstandings generated by the overlap of our minds, then it is very difficult not to converge to identical, or however fairly similar, positions. The important thing is to keep the discussion free of any kind of unverifiable preconception, confining ourselves to truth and sharing a common objective, namely, as we propose, semi-immortality.

15.1 Justice

The concept of Justice essentially encompasses the notion of compliance with the rules that are shared among multiple systems. There can be no happiness without Justice and neither diffused love. Therefore, Justice is one of the fundamental pillars of the *Society* of semi-immortality. However, as we all know well, in real life this is an extremely complex topic.

There is no need to resort to extreme or dramatic examples to introduce the problem in its essence. Just go to the motorway. You are proceeding on the fast lane in respect of speed limits. The car in front of you is proceeding at the same speed, but somehow uncertainly. While overtaking the other cars, it slows down, when going around a bend, it brakes, thereby considerably reducing its speed only to recover it on the straight stretch of the road. Probably, the person who is driving the vehicle does not feel very confident. You keep a safe distance, nevertheless the pace of the car in front of you doesn't make you feel safe, in particular when overtaking trucks. Carefully, you indicate to signal your intention to overtake it. No way, probably, he is not checking the rearview mirror or he doesn't understand what your intention is. A few minutes, and several highly predictable brakings later, you realize that you are running too high a risk and you decide to overtake it. You switch the headlights on full beam to signal your intention, but with no exaggeration. No way, probably, the person in front of you thinks to be entitled to the right to proceed in such manner, without perceiving its dangerousness.; after all, you are both travelling at a speed close to the speed limit and this allows you to be able to overtake a considerable number of vehicles. At the umpteenth abrupt braking during the overtaking of a truck, your realizational mind decides that if there has been a time when you were willing to run risks, well, that time is over. As you reach the first straight stretch with the right lane completely open, you slightly approach the car in front of you and do one of the things that bothers you most: you switch your left indicator and on and your headlights on full beam, and you honk. Finally, the car moves to the right, without reducing its speed. You swerve and you overtake the car. As you do so, you can read the mind of the person at the wheel: “here is just another bully who doesn't respect the limits and acts like he is the owner of the motorway”. You'd like to stop and explain the reasons for your behaviour and perhaps invite that person to refrain from driving so dangerously, both for himself and the others. Both of you feel a profound sense of unjustice. Who is right?

The answer again depends on the models of reference. Let us analytically examine the example above. You “see” the behaviour of the vehicle in front of you, whereas the other driver is not able to “see” it. If the other driver has never even found himself in a similar situation, perhaps due to a lack of experience, he might be the smartest and the most sensitive person on earth, but he will never be able to “see” it. After the tenth time a car flashed at him to overtake him, provided he is an intelligent person (whatever this term may mean), he might consider the problem. But if he is not, then he will continue to drive in that way for all his life. Until the first car accident.

The analysis may be further extended. Two persons endowed with a different level of intelligence, but with the same perceptions from their senses and equivalent past experiences related to the specific situation, might end up interpreting the same situation in opposite ways. Even assuming a similar degree of intelligence, however, there remain many models of reference which might be triggered within in either of the two persons; for instance, those belonging to the emotional module. The person who is driving the car in front of you might be a manager who is going through a depressive crisis due to professional problems, perhaps after experiencing a strong sense of frustration caused by the attitude of a bully and dishonest colleague. It is not difficult to guess what models of reference might be triggered by your seemingly aggressive behaviour. At the other extreme we may find a young woman who has just got her driving license, insecure with her looks, and with a few relational problems. Again, it is uncomplicated to imagine what models of reference might be triggered by your behaviour, whether you are a man or a self-confident woman.

Let us proceed assuming to equalize also the emotional module across the individuals. Therefore, we would have a situation where sensory perceptions are equal, the intelligence levels are comparable, past experiences are similar and the emotional condition does not result in excessive distortions. That is to say, an ideal situation that is never realized in practice. And, even in this case, there might be radically different understandings of the situation. Are you skeptical? Well, let us turn to you. You are driving a high-powered sports car. Or, alternatively, a family car loaded with luggage and children. Or, a somewhat tatty, not exactly brand-new utility car. It is not too much of a challenge to predict that, in each of the three scenarios , the person who is driving in front of you will exhibit different behaviours. These behaviours are caused by models of reference triggered by perceptions that are independent of the specific situation, the degree of intelligence and the emotional module, but that are nevertheless able to play a pivotal role in determining what the subject conceives as "fair".

These are the reasons why, in the society of semi-immortality, Justice cannot be administered as the present one. Who could be a truly impartial judge in the face of such a level of complexity? Who might justifiably be in the position to judge taking into account all the models of reference being activated? The solution is not simple. The use of machines will undoubtedly ease the path, but it will not solve the problem completely and, without a sound approach, the only outcome

Fig. 15.2. A few innate concepts related to *Justice*.

will be a further exacerbation of the situation. Again, we believe that the basic line of demarcation will be provided by the tendency to truth. Any player operating in the realm of Justice will have to pursue, without exception, such tendency, including: accusers, accused, judges, detectives, lawyers. The harshest punishment should be reserved to those who consciously violate it and an adequate sanction should be awarded to those who, in the domain of the debate, infringe it, even unconsciously. Nevertheless, when we speak of punishments, we should always bear in mind the concept of defense and not of offence and that some of our models of reference often push us in directions contrary to truth.

After truth, the other rules will follow, such as love and happiness, and they will be few and basic. The general rules will provide the foundations upon which the voluntary agreements among people and the conducts towards the systems unable to enter into agreements (not-fully-formed systems man, animals, plants and things) will be based. Any type of problem will have to be addressed with the approach of the models of reference. For example, the problem of abortion will be progressively solved as we agree upon the definition of system man and the principle of non-deterioration. Different societies of semi-immortality may arise, each characterized by its own definition of system man: in one society, the suppression of the embryo the second after fertilization might be considered murder, whereas, in other ones, it would be homicide only after the formation of the first nervous cell, in other again, only after the development of all the vital organs. The strength of this approach rests on the fact that, as all the societies build on truth as primary value, the aggregate outcome of their independent endeavours will be moving closer to the Solution to the Game. We expect the gradual elimination of all unconscious non-truths to result in the convergence towards one single form of social organization.

A concept closely related to Justice is violence. When is it right to resort to violence? When is it right to willfully damage another system? Let us begin by stating that, according to our approach, the resort to violence is the result of a non-knowledge or an insufficient level of intelligence and therefore, regardless of the circumstances, violence is an indicator of the distance from the Solution to the Game. The more harm a system (be it man, animal or society) does to another system, the lower its chances of attaining semi-immortality. A semi-immortal system will progressively achieve such a level of strength and harmony with the surrounding environment that it will have less and less to worry about possible attacks by other systems. In principle, someone's benefit does not imply another's loss; at worst, it has a neutral effect[143]. If we purchase, or barter a certain good or service, this will translate into gains for us and everyone involved in the transaction, if we steal something, there will be a gain for us but losses for anyone else[144]. A system attacks another one because it believes it has some chances of overcoming the adversary and because it envisages to benefit from the aggression. The society of semi-immortality will have to be strong enough to discourage any form of attack, be it due to the tendential absence of secrets, or the automatic deactivation of any kind of utility when control is lost[145].

The society of semi-immortality will gradually become able to provide those who comply with its rules with the technology of the indefinite extension of life. Therefore, we think that it will be extremely difficult to encounter anything of greater interest in other societies: only the disbelief in the feasibility of this process will be able to preserve the other societal forms, whether political or religious. When the facts demonstrate the reasonableness of this development, the convergence will be inevitable, although, perhaps, the paths taken will be different reflecting those areas in which knowledge is not yet certainty.

15.2 Education

The concept of Education basically encompasses the notion of preparation of the systems to the Game. Only the work of the players who have preceded us and of those who are presently engaging in this endeavour can trigger our advance towards the understanding of the Rules. No system alone will ever be able to attain the Solution, forasmuch as any idea is both the fruit borne by previous ideas and the seed for future ideas. Hence, the education of the players is another cardinal pillar of the *Society* of semi-immortality.

Our view is that the most efficient system to cultivate the players is one based on the transfer of people rather than the transfer of ideas. We should not aim at aseptically transferring ideas, but rather at transmitting the experience and the history of the best players. New players must be comprehensively educated and they need to have a sound knowledge of those who have preceded them. One single idea might turn out to be wrong or fail to withstand the test of time, nevertheless the intelligence of the player remains unaltered and the paths of his thought are a continuous source of inspiration. Furthermore, the players must be aware of the risks of the game. Our mind is fragile and our software, as we may honestly confess, contains several flaws. Browsing through the biographies of many great players, it is quite striking to notice how they were affected by relational problems, quirks and paranoias. Nowadays, we know that a person's intense mental activity causes an unusual hormone production which, in the medium-long run, may affect many other aspects, such as the general mood state[146]. A distinct intelligence may, in some cases, lead to a lack of care for one's own body, thereby undermining intelligence itself from within. As we know well, mind and body are strictly related and under each other's mutual influence.

The core problem of the Education of semi-immortality is that the explanation of the essence of a genius requires at least a sufficiently intelligent and cultured person to understand it. How many times have we felt unconfortable about the impudent use of, for instance, quantum physics, by people who didn't even know the experiments underlying the paradoxes? How often, while listening to people citing, for instance, Friedrich Nietzsche, have we begun to wonder whether they had read at least one of his works? The study of a great player must necessarily go through the direct reading of his works and the adequate understanding of the context he lived in. The reference scenario is the Game, the goal is the understanding of the Rules, the Prize will be semi-immortality. In this perspective, it is not so difficult to reorganize the history of human thought (this same book is a possible example), to prepare new players and to continuously retrain those who are already at work. Also in this case, technology will provide its considerable contribution. Starting from the insights of Maria Montessori,

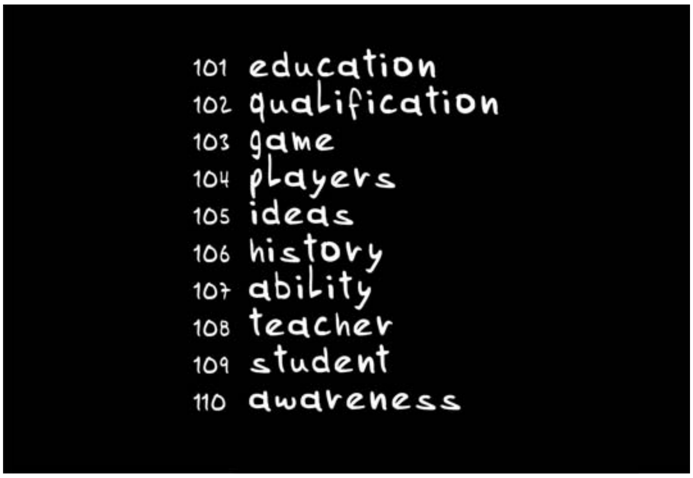

Fig. 15.3. A few innate concepts related to *Education*.

dating back to the late Nineteenth century, many scholars have been effectively employing the scientific method and technological innovations to support the transfer of knowledge, most notably Piero Angela. The development of "educational" artificial-Selves able to interactively present the ideas, the life and the works of the great players will mark a cardinal step in the construction of the Education of semi-immortality.

As it should be clear by now, according to our framework, the human mind is composed of the following modules of reasoning: logical, analogical and realizational. Therefore, the Education should base the formation of players upon the enhancement of each module and the consequent educational path in the scientific, philosophical and technological domains. Moreover, consistently with the definition of "system man" being given here, an adequate attention will have to be devoted to the body, the mind and the environment. The ultimate goal of Education will be to enable all persons to live better and as long as possible relying on the acquired knowledge. Further-

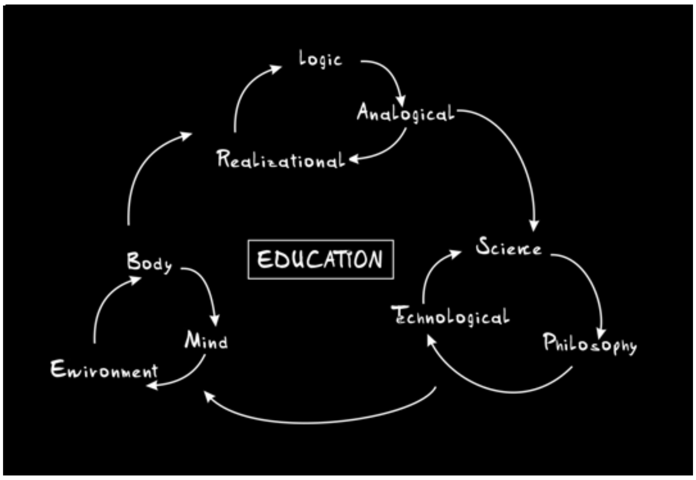

Fig. 15.4. The Education of semi-immortality.

more, resting on the principle that everyone may provide one's own contribution to the Solution to the Game, Education will have the task of promoting the preparation of the players in view of the attainment of new knowledge.

Technological innovation, coupled with the progress of scientific and philosophical thought, will allow us to cultivate "complete" and "aware" individuals. We think that a semi-immortal individual will necessarily be accomplished in all of his aspects and fully aware of the rules governing both his mind and the reality that surrounds him. The time at one's disposal will progressively increase, thereby further stimulating this essential process of accomplishment and awareness.

15.3 Economy

The concept of Economy basically encompasses the notion of the organization of available resources among the various systems. Notwithstanding the current imbalances, one of the clearest signs of our advance towards the Solution to the Game is precisely the exponential increase in the availability of resources over the last decades. Such exponential increase, which can be ascribed to technological innovation, has been accompanied by a growing number of social organizations, thus a structural shift away from a condition of mere survival.

There are things to which we pay little attention, other things that we simply don't know, and further ones that we do know, albeit without grasping their true meaning. For instance, what does it mean to eat meat only three times a year? To add the eggs to the flour of the dough only on Sundays? To use just one plate and one glass for the whole family? What does it mean to have a bathroom outside the house in the form of a hole dug in the land and covered by four planks of wood? What does it mean to have a life expectancy systematically below fifty years? What does it mean to have a dozen brothers and sisters and to live all in one room? What does it mean to try to warm up the bed with the ashes to be able to sleep in winter? Today, these situations are simply unconceivable for about one billion human beings, but, until a few decades ago, they were the norm for nearly the totality of the world population. The indefinite extension of life obviously relies on the availability of sufficient resources to ensure survival and the necessary technological progress.

The Economy of semi-immortality will permanently highlight the concept of resources as a means and not as an end. The victorious model won't be one who is "shut up like a clam", but rather one who "will live better and longer". Of course, these two concepts are related, but not the same: beyond a certain threshold, any increase in the availability of resources does not lead to a growth in the quality of life. On the contrary, since the pursuit of greater wealth might induce

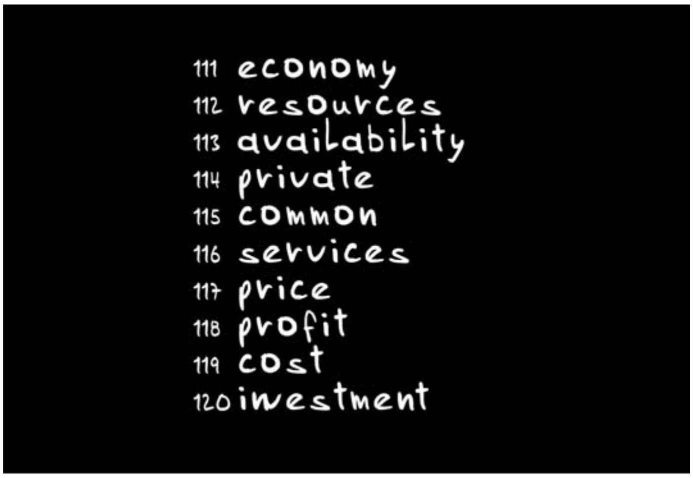

Fig. 15.5. A few innate concepts related to *Economy*.

us to neglect other equally important factors, the unnecessary accumulation of wealth is likely to result in severe imbalances that may undermine the soundness of the results achieved.

We expect the concept of property to remain one of the conceptual foundations of the Economy in the coming years. Property ensures the differentiation that underlies evolution and differentiation is, not by chance, strongly correlated to the concept of happiness. Conversely, we expect the concept of "state" to lose a substantial part of its meaning. Those areas where the so-called "public" intervention is necessary will progressively diminish as a consequence of the widespread increase of resources, the gradual evaporation of the concept of delegation and the concurrent emergence of a variety of social organizations that are different from and in competition with each other. If the definition of the "system man" (with all its implications) may represent a dividing line among the diverse *Societies* from an ethical point of view, we expect the organization of the tax system to play an equivalent discriminating role from an economic standpoint. According to our approach, the *Society* of semi-immortality will have to be a *Society* of individuals who aim at the Solution to the Game. We believe to know, at least in general terms, how to solve the Game. We know with good approximation what are the necessary steps. We have identified the ethical and aesthetical guidelines. We know the fundamental pillars upon which the *Society* of semi-immortality should rest. We believe that this context may also enable us to derive the adequate level of fiscal pressure and the resulting hierarchy of investment. The individual should not be called to support other individuals he doesn't regard as useful or works he doesn't view as necessary. In our opinion, once we escape the Economy of survival, the basic inspiring principle will have to be a fair payment for a service rendered and the main reason to invest should only be related to the progressive approach to the Solution to the Game.

The Economy of semi-immortality will be based on the tendency to truth and the consequent transparency. Once a rule, for instance in the domain of taxation, is agreed upon, it won't be conceivable to have a systematic non-compliance with such rule without running into the exclusion from the *Society* which one had freely decided to join. The agreements between the various systems (individuals, businesses, organizations) will have to be made public and thus the same holds for their assets and incomes. No one should be able to "cheat" just as no one should be able to instill doubts to harm someone. Knowledge itself will have to be made available to anyone who might have an interest in accessing it, provided the single player is entitled to receive the benefits from allowing everyone to make some progress. The Economy of semi-immortality will have to be sufficiently sound to be able to develop within the other currently existing economic organizations. A tax burden close to fifty percent coupled with an invasive, and often demagogic, state regulation, of course, have a suffocating effect, but they may also produce a fortifying effect. We expect the Economy of semi-immortality to be the natural evolution of the economic organization of the so-called Western world. We envisage that a fairly wide convergence among nearly all the forms of free *Societies* will be achieved by small, but incremental changes over time.

15.4 Assistance

The concept of Assistance fundamentally encompasses the notion of aid in the resolution of problems. Even the most brilliant players need Assistance, sooner or later. Both our hardware and our software are far from being perfect, therefore they require frequent repairs or, more simply, they need help to solve those problems that might arise and to which we are unable to identify a solution autonomously. We believe that the fundamental guideline of Assistance rests on the request for help. Assistance must never intervene without an explicit request, just as it must step in whenever it is requested. An individual must be free to choose whether to be helped or not and he must be kept constantly informed about the type of aid he is receiving. Symmetrically, a request for help must be accepted with no distinctions. The utter transparency which the *Society* of semi-immortality must strive to will be the main regulating tool of this mechanism.

Problems can be extremely varied in nature. First of all, there are diseases that, as we know well, may stem from genetic, environmental and mental factors. Diseases are caused by conscious non-truths, which are due to our weakness, or by unconscious non-truths, which can be ascribable to our ignorance. A proper education is the first step for anyone who is willing to take the path towards semi-immortality. Education allows the individual to become stronger in all of his components and to gradually get rid of non-truths. Nevertheless, the path to be covered is a long one and we all make mistakes. The

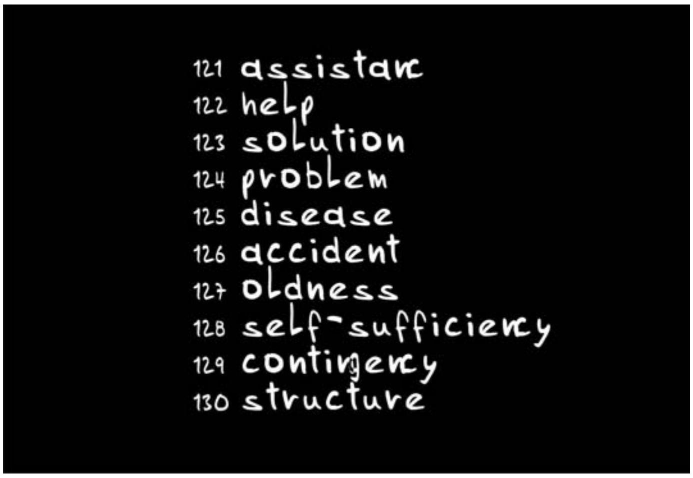

Fig. 15.6. A few innate concepts related to *Assistance*.

task of Assistance is precisely to try to repair the damages, both the suffered and the caused ones, and to fix any relative malfunctioning.

In addition to diseases, there are the accidents, where by accident we mean all those phenomena that tend to be out of our control. If we drive in a state of personal instability and we crash into a tree, that is not an accident, but it is rather a damage we suffer, or inflict, because of some stupid mistake of ours. Being struck by a lightning while sunbathing on a beach qualifies as an accident. From the standpoint of semi-immortality, it is useful to reason about the concept of accident. We think that, in the close proximity of the Solution to the Game, the occurrence of accidents in the strictest sense will no longer be possible inasmuch as our comprehension of the reality surrounding us will be thorough. It is our opinion that the human mind will be the last facet of reality to be fully understood, therefore, only our own errors of conduct, or the inaccuracy of others' behaviour, will be able to cause us damage.

A third category of problems that require the intervention of Assistance is related to the temporary or structural inability of some individuals to provide for their own survival. This point is closely related to the notion of system man and it is a potential source of conflict with the fundamental principle that the only acceptable intervantions are those upon explicit request. In our opinion, no one can judge others' needs and, in light of the progressive dissolution of the concept of delegation, technology will have to help us provide clarity to those areas where the real intentions of individuals are hard to ascertain. The level of inability encompasses all possible gradations, from a momentary difficulty in entering the labor market, to an irreversible degeneration due to a still incurable disease. As we wait for getting sufficiently close to the Solution to the Game, oldness itself is accompanied by a progressive and still too often dramatic decrease in efficiency. We believe that, even in the most extreme situations, no one is entitled to take the place of the decisions of the individual, regardless of the consequences. An individual may temporarily delegate his decisions to others, but, as previously pointed out, we think that he must nevertheless be continuously informed. The criteria of truth and consciousness must never be discarded.

In the *Society* of semi-immortality, the primary concern of Assistance must be to solve the contingent problem in the shortest time possible and to act on the structure in order for the problem not to reoccur. This criterion should apply to all the areas of intervention, from diseases to the aspects related to survival. We know that the onset of a disease is never an accidental event, but is always the result of a series of factors. Regardless of the seriousness of the situation, the solution to the contingent problem is obviously the first aspect to tackle, but equal importance should be given to the identification of those factors that led to the disease and to the most effective strategy to neutralize them. Healing occurs only when the underlying causes are eliminated, not when the symptoms are temporarily stabilized[147]. We also know that these three moments are in increasing order of difficulty, relieving the immediate problem is relatively easy, identifying the underlying causes is difficult and solving them without causing collateral problems, which may frequently be worse than the disease itself, is an extremely arduous task.

15.5 Enjoyment

The concept of Enjoyment basically encompasses the notion of the achievement of both physical and mental pleasure. The Game is long and demanding, the outcome is uncertain and the imperfection that marks our mind-body system still leads to a great load of pain and suffering: we must try to enjoy ourselves as much as possible, with method and will. We consider Enjoyment as one of the main units of measure by which we can evaluate the distance separating us from the Solution: a Society where Enjoyment is widespread is much closer to the Solution than one where Enjoyment is hindered or even forbidden. We share this conception of Enjoyment as a crucial element with the vast majority of the great players and some of them, even from very different positions, have made it a central feature of their thought. Among them, we may mention Lorenzo de Medici and Erasmus of Rotterdam or, coming closer to present days, Walt Disney and Hunter Patch Adams.

Fig. 15.7. A few innate concepts related to *Enjoyment*.

Just like everything else, also the Enjoyment of semi-immortality derives its guidelines from ethics. Thus, truth and love first and foremost and, then, happiness with all the inherent dangers related to dependence and lack of awareness. The Enjoyment of semi-immortality is connected to the concurrent achievement of physical and mental pleasure. This leads to the highest amplification, both in terms of intensity and duration. Any sense organ, internal or external, may contribute to the achievement of pleasure. A dish, a painting, a musical piece, a scientific discovery, a sexual game, an adventurous journey, an ironic one-liner: enjoyment can be drawn from a multiplicity of forms and none of them should be neglected. Obviously, Enjoyment must comply both with the rules of ethics as well as the rules of aesthetics. Therefore, it must aim at meeting, at an individual level, the criteria of originality, completeness and harmony and, at a social level, also those of essentiality and universality.

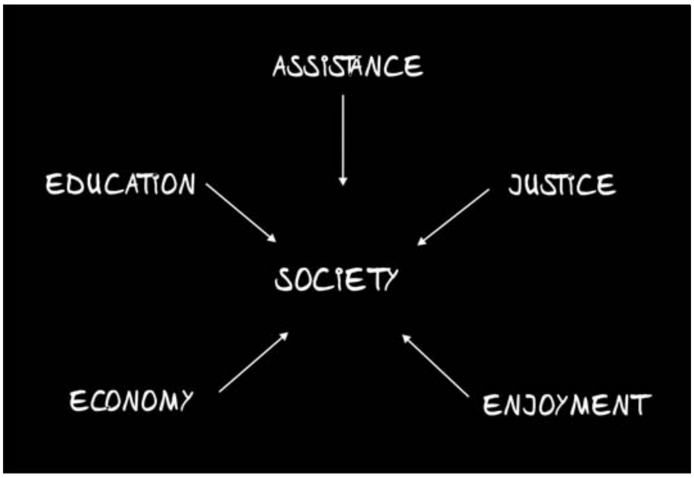

Fig. 15.8. The foundations of the Society of semi-immortality.

Within the *Society* of semi-immortality Enjoyment is to be taught and encouraged. It is to be taught because our innate models of reference mainly tend towards the satisfaction of immediate pleasure, thereby disregarding long-term pleasure, and because only an adequate level of consciousness enables us to experience it continuously and without mood swings or, even worse, avoiding the risks of the various forms of dependence and addiction. And enjoyment is to be encouraged because it is essentially linked to the participation of other individuals, hence fostering the exchange of enjoyment is an efficient option. In fact, enjoyment may be conceived as a resource that is both given and received. There can be no real pleasure without this two-directional exchange flow, which cannot be simultaneouss, as in the case of a painting or a scientific discovery, but is nevertheless a prerequisite for the attainment of true pleasure. By means of Enjoyment, a strong self-referential component can be brought within *Society*: irony is one of the crystal-clearest manifestations of intelligence and it is the main antidote to dogmatism and thus to all its inevitable consequences in terms of violence and unhappiness.

Enjoyment encompasses virtually all the problems related to our mind-body system. Its thorough analysis leads to the understanding of the underlying mechanisms, while learning to control it provides us with valuable indications for any aspect of our behaviour. An Enjoyment devoid of ethics leads to destruction, while ethics devoid of Enjoyment leads to immobility. An Enjoyment that is solely based on the body leads to physical disease, while an Enjoyment that is solely based on the mind leads to mental illness. The resort to exogenous components, such as drugs or alcohol, leads to addiction and weakness. Enjoyment consists of several levels, those who draw pleasure from the initial levels but ignore the higher ones cannot grasp their meaning. Enjoyment is a resource which every individual is endowed with, regardless of any other considerations related to wealth, power, or culture. Enjoyment is a creative energy and it will constitute one of the fundamental pillars of the *Society* of semi-immortality.

[143] In our opinion, the notion that "someone's gain does not necessarily imply someone else's loss" is closely related to the concept of intelligence. As we have come to know well, human intelligence is a very complex structure to describe and it is often extremely difficult to calculate all implications, and, at times, even initial assumprions may seem not to hold true. However, there is an very interesting, and we dare say, very linear attempt to define both intelligence and its opposite, namely stupidity. The author of the book "Allegro ma non troppo" ("Happy but not too much") is Carlo Cipolla and the thesis therein presented is extremely simple but, at the same time, surprisingly effective. The central idea is that, on the one hand, our actions, our behaviours and their consequences on ourselves and others are the most important indicators of our intelligence quotient and, on the other, these can be measured (or at least sorted) according to a "cost-benefit" approach. On the basis of this scheme, we can identify four types of people: the helpless, who cause losses to themselves while generating benefits for others; the bandits, who, on the contrary, promote their own cause while damaging others; the stupid are those who, by acting without any logic and often unpredictably, cause losses both to themeslves and others (in a perspective of semi-immortality, the total unpredictability of their actions make them the most dangerous type of person). Nevertheless, the real genius of Cipolla's contribution lies in his brilliant and, in our opinion, convincing definition of human intelligence: a person is truly intelligent when she generates benefits both for herself and the people close to her (the greater the overall benefit produced, the higher her intelligence).

[144] By the same token, from the standpoint of the society of semi-immortality, also charity is detrimental: the act of giving someone a sum of money without receiving any benefit in return results in a loss with no gains. It is far better to try to help anindividual in such a way so that we too can obtain some gain, perhaps lower, but still a gain. Charity, understood in an absolute sense, is harmful and it inevitably leads to distortions.

[145] Ever since our earliest studies in the field of cognitive sciences, we have been intrigued by the fact that within the same person there may coexist, and even in an extreme manner, "good" models of reference and "evil" models of reference. An inveterate thief, who has just robbed a house causing fear as well as both economic and emotional damage to the people who live there, may, at the

same time, be a loving father with his children.A tangible progress towards the society of semi-immortality does not require many declarations of principle. It is sufficient to study and understand how the human mind actually works. The tendency to the values of truth and love can be identified as the conditions that best promote the development of a happy society. But this is just the beginning: in the mind of every man there are also the models of reference of falsehood, hatred and, perhaps dormant and ready to spring back under certain conditions, even those of brutal violence. From this stems the necessity of accurately unveiling the underlying dynamics of these models in order to develop adequate tools enabling each of us to control them. The study of the mind also suggests that the approach of "religious" derivation, which is based on the concept of reward/punishment, is not always appropriate and it should be gradually replaced by the more "objective" concept of defence/offence. If a robber wants to steal from us, we must try to defend ourselves and, to this end, we have to attempt to be appropriately rich and strong. Rich to minimize the actual damage that may be caused to us by anyone else's action, and strong toeffectively prevent such damage from being generated. Conversely, at the present state of knowledge, the "a posteriori" use of force is a controversial topic. In the context of the society of semi-immortality, if an individual caused a damage to me, what would be the most appropriate behaviour that should be taken afterwards? Should we blame it on ourselves for not avoiding such occurrence or take any possible action to put the other in condition not to harm again? We believe that the starting point should be to blame ourselves because we have certainly done something wrong. If our error were due to a distraction, then we would have to commit ourselves to improve our defences and we should be, in a sense, "grateful" to the behaviour of the other individual as it has highligthed a weakness of ours (considering that we are still alive, forasmuch as we are reflecting on the problem). Conversely, if we hadn't had any real chance of defending ourselves, we should simply try to prevent the other from doing any harm, by "isolating" him in case of possible future damage, or "eliminating" him if there was an objective risk to our life. In the society of semi-immortality, any a posteriori actions, such as the isolation or the elimination of an individual, even if taken in a defensive perspective, are nevertheless manifestations of structural weakness.

[146] The communication process within our body is not only hierarchical, but also strongly correlated as well as a two-directional exchange: the vital reactions

of the human body include cognitive functions that also involve non-nervous molecules and organs (for, instance, it is now a verified fact that some hormones participate to the construction of memory). Hence, we can justifiably assert that the endocrine, immune and nervous systems interact for the proper regulation of our body. Some organs, such as the thyroid and the hypophysis, only produce hormones; on the other hand, in other organs, including the brain (which is itself considered a sort of endocrine gland), the distinction among neurotransmitters, neuromodulators and hormones is blurred, not to mention the hormone-producing cells of the immune system. The principle underlying it all seems to be the self-referential character of our organism: the brain controls the endocrine system whuch acts on the brain itself by means of circulating hormones. In cases of elevated levels of mental activity, there is an increase in stress and the body needs to produce more glucose to amplify the amount of available energy. To this end, the endocrine system mobilizes a number of very different hormones. This increase of production is not without consequences: the increment of ACTH (adrenocorticotropic hormone), cortisol, catecholamines (adrenaline, noradrenaline, dopamine), growth hormone, etc… affects several other body functions; it can result in a weakening (or a strenghthhening) of the immune system and, in particular, both the mood and the quality of thinking can be significantly influenced. We deem it probabe that the relationship between genius and recklessness may be explained, at least in part, by the exceptional hormone production stemming from a intense mental activity. Many forms of paranoia or, more simply, of obsessive thoughts that frequently accompany intellectually very gifted people may derive from an "excessive" production of hormones (for example, catecholamines) which too often is not sufficiently balanced by and adequate physical activity.

[147] By the same token, in the area of assistance to survival, we must rely on the famous Chinese proverb according to which "it is better to teach how to fish than just to give a fish".

TECHNOLOGY OF SEMI-IMMORTALITY

16. Projects aimed at Semi-Immortality

In this part of the book, we will take a more relaxed approach to the various topics, as we will be less concerned with the formal aspects and much more concerned with the practical applications. If we truly want to achieve semi-immortality, we have to "act". Sound scientific and philosophical foundations are essential, but alone they lead nowhere. They must be translated into practice, brought within our society and out of the research laboratories, the books and the academic debates.

From our standpoint, every year we conceive, on average, about a dozen projects of particular relevance. Some turn out to be valid, whereas others rapidly exhaust their drive as they are confronted with reality. Some projects fall into the category of "pure research", whereas others belong to "applied research". However, none of the two fields of research are directly connected to the "business area". The economic rewards, if any, come only at a later time. Over the years, this marked separation between the domains has proved to be quite efficient. On the one hand, it has allowed us to choose research directions independently from strictly economic considerations, and on the other hand, to safeguard the profitability of our businesses that have always been the only source of financing for all the other activities. In addition to the two research areas and the economic area, there exists a fourth sphere, namely the non-profit one, which is concerned with the care of patients and, more generally, with the psycho-physical wellbeing of people. There is a considerable diversity in the focus of the various areas, therefore, we have tried to keep them as distinct as possible, even at the cost of delaying the thorough understanding of the path in its entirety also for our closest collaborators. This book wants to be for some of them a (perhaps belated) attempt to display the whole path. But, as lately we found ourselves repeating several times, we didn't want to put ourselves forward even one minute before being really "ready", before, in our opinion, the circle had been truly closed.

The five projects we will describe in the following pages cover many of the areas dealt with by this book and we have selected them according to criteria of significance and feasibility. It will be interesting to notice that some parts are common to several projects, but this should not come as much of a surprise since we are dealing with a "unique project". From a philosophical point of view, our path has always relied on the simultaneous involvement of all the aspects of a person's life. Only completeness will bring us closer to semi-immortality. To put it into everyday terms: money is important but it is primarily a means to an end, it is equally substantial to take care of the others and try to help them, if you have been lucky it is "fair" (and useful) to seek to share your luck as much as possible; by the same token, it is good to study and train, as this is perhaps the main drive, but it is equally important to have fum; finally, one should never forget to find some time to pause and try to get closer to something that, by definition, will be out of the reach of our knowledge form many years to come, although, within ourselves, we know that it is somewhere out there, yet to be discovered.

From an architectural point of view, the centre of "our" city of semi-immortality will necessarily have an hexagonal base. In turn, from each side there will arise the six main aspects of human life. The first hexagon will be the contact point with the external world, the port of entry and exit. The other five will represent economy, education, enjoyment, assistance and the unknown. The five projects we are about to present in the

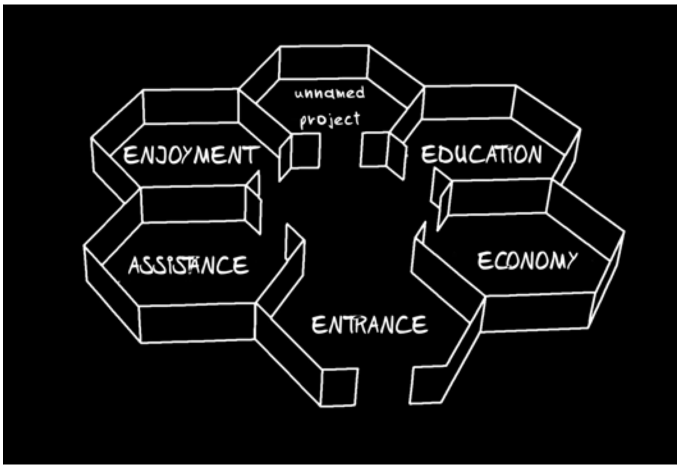

Fig. 16.1. The "city" of semi-immortality.

following pages symbolize each area[148].

The projects we will expose contain a number of goals that many people view as "unreachable" (or however beyond the scope of human abilities) and some also involve non-trivial ethical implications. We may say that we have never lacked courage. A few collaborators and friends of ours even argue that, courage ultimately is our predominant trait and that we owe our good luck to our ability to take unconventional stands and not to take anything for granted. A few of our stands, such as rejecting any possible contact with any organization somehow referable to the "state-controlled"[149] domain and our pursuing the value of truth at any cost also in the economic department, have not always been fully embraced by our interlocutors. Of course, we work with many other research centers with whom we exchange opinions and projects, yet we prefer to keep both the direction of our research and the goals to attain under our strict and direct control. And, until now, this has proved a successful strategy.

When people tell us that they view a certain goal as unattainable, we mentally retrace all the times we had been told similar things and then facts proved us right. Starting back in the year 1981 when no one (no one whatsoever) believed we would manage to file the whole product list of a large distribution company on a 360 KB floppy disk (the good old days!), but there was no magic: we simply anticipated the future systems of data compression. Similarly, we would like to mention our first decisive contribution, again against all the odds, to a person whose life was in danger due to leukemia. And, again, there was no magic: we simply employed the mind-body models developed by our reasearch laboratory, namely those same models that had proved extremely effective in supporting the treatment of “less severe” disorders such as phobias and addictions. We like to keep control over the whole process, develop everything in-house, check each step carefully, even those that might be regarded as obvious by nearly all the other researchers. Even today, we often receive odd looks when we explain, for instance, that the relational *data base* underlying all of our software applications is “proprietor”. The point is not that we don't trust the others (although, perhaps, in part it is); actually, the fact is that we like to gain a thorough knowledge of everything we employ in our researches and, if we consider it a strategic asset, we prefer to develop it in-house, so as to retain control over the whole operation.

The strategy of complete independence and full control over our resources and projects might not be the fastest, or cheapest, route, nevertheless, so far, it has been proving a particularly efficient one: we wouldn't have been able to achieve many crucial objectives without a sound understanding of the previous steps, and such understanding can be made possible only through a direct, and often laborious, reproduction of such steps. Furthermore, we have never been in a hurry nor have we ever been interested in the economic side per se, thus, for the time being, we see no reason to change direction.

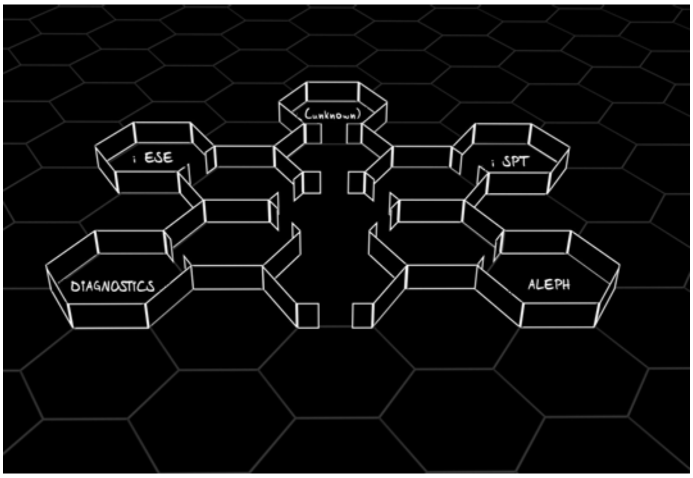

Fig. 16.2. The five projects.

Our primary goal is semi-immortality. Obviously, we are not able to know whether we will manage to attain this goal, yet we are sure someone will succeed eventually. Is this megalomania on our part? Perhaps. Nevertheless, in a sense, we have no choice: this is our task and this is what we try to accomplish with the utmost of our abilities. In the meantime, we are structurally happy, we think we make the people close to us structurally happy as well, we enjoy ourselves and amuse others. And, perhaps, we are able to provide those who may be interested with a reasonable explanation about the meaning of existence and the reality surrounding us. Not exactly peanuts.

It was difficult to single out five projects to present herein, especially in terms of discarding the others. We love all of our projects, to us they are a bit like our children. Once they are accomplished, it is relatively easy for us to detach ourselves from and look at them with objectivity, but we find it hard to privilege one over another while they are still "under construction"[150]. The conditions suitable for their development and the implied guidelines of the various projects are described in the chapter of the philosophical part which is devoted to the Society of semi-immortality (it won't be complicated to associate each project with the corresponding paragraph). The basic scheme underlying each of our activities is always the same, the ultimate goal is one, whereas connections and stratifications are many.

As far as the "economic" domain is concerned, the project we will describe has as its object the creation of a life insurance company. The insurance market has always been one of the main domains of application of the technologies developed by our research laboratory. Inasmuch as it is a markedly virtual market (meaning that the item sold is essentially a contract), it is particularly well-suited to be dealt with by means of computer science. Moreover, the statistical-mathematical component is extremely important, thus mastering this element leads to significant differentiations among the various *competitors*. The core idea of our insurance company is the perfect correspondence between the interest of the customer (i.e. to live as long as possible) and that of the supplier (i.e. to pay the lowest number of claims). Of course, this tenet will have to be embedded in a context of truth and transparency, consistently with the fundamental principles that are expressed in this book. We believe that Aleph Vita (or whatever its name will be once ready) represents a meaningful example of a business that is perfectly aligned with the ethical and entrepreneurial criteria related to the rising economy of semi-immortality.

The project belonging to the domain of "assistance" is focused on what, in our opinion, is currently the most urgent issue in the field of psychoneurophysiology: the identification of methods to accurately measure a person's level of health, and in particular to assess the actual effectiveness of a therapy with respect to another. In a perspective of semi-immortality, it will be vital to know at any time the theoretical "distance" from our death and the diagnostic tools currently available are, in this respect, completely inadequate. For a long time, we still won't be able to avoid the proverbial lightning that might strike us, but being aware of our true state of health day after day will enable us to adopt the most convenient lifestyles and, should problems arise, the most effective treatments. Until we are considerably distant from this "measure", semi-immortality will remain a goal out of our reach.

The project in the sphere of "education" is concerned with the creation of a postgraduate master's degree aimed at teaching the basic guidelines of the budding culture of semi-immortality. From our standpoint, the preparation (as well as the identification) of the "players" is one of the activities with the highest strategic value in the coming years. If we manage to mobilize a considerable number of qualified people swiftly, then it will not be entirely impossible for our idea of semi-immortality to be realized on schedule.

The focus of the project in the area of "enjoyment" is the definition of i-ese, namely a new language conceived to allow an optimal interaction with the artificial-Selves deveoped by our research laboratory. This new language, once its effectiveness is tested, may prove to be a valid candidate also as "natural" language for the human beings themselves, or it may even turn out to be a substantial contribution towards a possible "universal" language. I-ese attempts to reach the very essence of communication, in line with our conception of the society of semi-immortality and as a direct derivation of our idea of the models of reference. Since artificial intelligence will enter our lives through the front door of enjoyment and it will be the main tool at our disposal to overcome the obstacle of boredom, an efficient, profound, stratified and unambiguous communication system with the artificial-Selves will become an essential necessity.

Finally, the project in the area of the "unknown"... that one is difficult to summarize in a few lines, it should be simply read. How would it qualify as project in the area of the unknown otherwise?

17. Aleph Vita

Let us begin with one of the potential economic engines of the society of semi-immortality. The project of the Aleph Insurance Company was first presented during the 1996 edition of Smau. Several years later, there are still many who remember our booth at the Milan fair exhibition of *Information Technology*. It was a sort of building site, with picket fences, steel cables and raw wooden beams. Within our exposition area, which was aimed at conveying the precise concept of *work in progress*, we were presenting some of the main ideas that would characterize the technological development of the following years. There were ten monitors all over the "building site", by means of which we were illustrating the ten ideas we deemed the most innovative ones and, for each of them, we were exposing a project applied to the field of insurance. In the brochure we wrote: "The place of honour in the gallery belongs to the Internet. As far as the information world is concerned, this phenomenon is bringing about even more momentous consequences than the advent of the personal computer. Internet is making it possible to realize in practice a considerable number of futuristic visions elaborated in the research laboratories." It was 1996 and we were already able to show, on the first monitor, a few examples of policies sold on line. The second monitor was devoted to interfaces based on virtual reality, and so on up to the tenth monitor where we were delineating the "Aleph Insurance Company" project.

The two basic ideas underlying the Aleph Insurance Company were "economic convenience" and "truth". The new technologies allowed a dramatic reduction in the operating costs and, at the same time, the utmost transparency towards customers. Furthermore, technology would also brought about two additional remarkable functional and perceptual innovations. First and foremost, it would be possible to create a virtual world, a precise reproduction of the real world which a customer (but also a supplier or employee) could relate to. For instance, the "real" headquarters of the Company would have to be identical to the "virtual" headquarters, so that there would be no significant perceptual difference between a physical visit and a visit via the Internet. Moreover, any type of information would have to be made available and accessible ito anyone (of course, except for the personal information that could be consulted only by those directly involved). The feasibility of this idea would rely on the enhancement of the technology of search engines and virtual assistants specialized in question/answer interactions.

Throughout the following years, the Aleph Insurance Company project has been further strengthened thanks to the integration with other projects developed by our research laboratory and, obviously, thanks to the remarkable improvements in the available technology, among which, incidentally, nearly all went in the direction we had predicted. At a conceptual level, the main evolution of the project dates back to the end of 1998 when, by joining our researches in the field of the extension of the human life span, our focus shifted from a generic insurance company to the creation of the Aleph Vita Insurance Company.

The Aleph Vita project builds on a simple core idea: "let me live as long as possible". The interests of the customer and those of the company are perfectly aligned. The customer pays not only to to ensure his beloved ones an economically less problematic life in the event of his death, but also to "attempt not to die", or at least, to live as long as possible. Symmetrically, the company receives money not only in view of possible future outlays (it must be borne in mind that, beyond a certain age threshold, the insurance companies are no longer willing to offer life insurance companies), but rather it stands alongside the client to minimize such risk.

17.1 Constitution and organizazion

Obviously, both the Italian and the European legislation regulating the activity of a life insurance company is very strict, from the transfer of capital stock to the mandate of the various controlling bodies, from periodic administrative duties to the definition of risk management criteria. In essence, the regulatory framework in place is consistent with the philosophy of transparency and truth underlying our project[151]. On top of this we add the idea that everyone may share one's own life experience with the others: therefore, a disease and its solution become a *case history* available to everyone (except the essential safeguards for *privacy*), but even an unfortunate negative outcome eventually develops into study material and experience for all the others. Not to mention those who manage to stay consistently healthy over time. Each client (and of course we will be the very first to sign the policy) will receive an extremely "individualized" service characterized by the extensive use of the available technologies, without nevertheless neglecting the man/man relationship which must constantly remain the primary focus. Undoubtedly, semi-immortality will not turn us into mere "figures" or "boxes", in fact, it will be just the opposite (also in light of the dramatic increase in the length of our stay in this world).

We like to think of Aleph[152] as the natural historical and technological evolution of the *Lloyd's Coffee House* that, at the end of the Seventeenth century, saw the birth of the register of all vessels plying the dangerous seas of the time, thereby laying the foundations upon which the most important insurance company would be constructed[153]. An essential component of the project is the sensible exchange of information: so many were the times when our laboratory of psychoneurophysiology succeeded in uplifting a situation that seemed hopelessly compromised relying on a reasoned selection of the information related to the latest treatments available! The problems we are confronted with are very similar to those encountered by the sailors, the merchants and the shipowners of three hundred years ago, for instance the issue of information selection. Any rumour concerning the fate of a certain vessel, perhaps in front of a pint of beer, had to be accurately verified and interpreted before it could acquire any economic relevance. By the same token, today, a supposed "miraculous treatment of hypertension" we might happen to find on the Internet must be properly tested and understood in the appropriate context before it can be qualified as usable.

Compared to the standard organizational structure provided for by law on the one hand, and to those commonly adopted by the existing insurance companies on the other, Aleph exhibits two significant new features, the first is "internal", while the second is "external". The first, internal element is the creation of an advisory committee composed of members whose essential trait will be a high degree of intelligence (as measured according to our representation model of the human mind, therefore taking into account all the different types of intelligence). According to its constitutive intentions, this committee aims at being more than merely a group of highly qualified people, it rather aims at being a forum where a wide variety of ideas and solutions are exchanged and shared not only with the stakeholders of Aleph, but with the whole rising society of semi-immortality (which is closely tied to Aleph). The committee will have several distinct underlying structures, each concerned with specific areas of the current society, namely the pool of future "advisors". The second novelty is related to the information that will be gradually collected and made available to all customers at both an aggregate and an analytical level. This information will cover not just the various commercial and technical aspects of the company, but, first and foremost, the fundamental objective we all will be pursuing, that is to say the indefinite extension of human life. At the earliest stages, this tendency towards transparency will collide with any needs to defend from competitors. Nevertheless, we think that this mechanism, once established, will prove a successful choice in all respects. And should any competitor better than Aleph enter the market, all the better. The essential thing is the attainment of the goal by someone, to the benefit of everybody.

17.2 The policy

In the society of semi-immortality, truth and transparency will be the guiding principles of any agreements between individuals. Furthermore, at an individual level, any person shall be entitled to the freedom to choose the behaviour she deems the best one. We may express this concept with the following symbolic phrase: "there exist both people who live over one hundred years while smoking a pack of cigarettes a day, and people who develop lung cancer without ever smoking, nonetheless we can safely assert that, on average, smoking increases the chances of developing lung cancer".

As far as traditional life insurance companies are concerned, for many years, the crucial determinant of the cost of insurance coverage has been the age of the insured, thereby making insurability decisions based on the health of the prospective insured at the time of underwriting[154]. In line with its guiding principles, Aleph Vita will completely overturn this concept by using a mathematical formula to periodically assess the cost of each insurance coverage. Such formula will take into account each person's physiological parameters, thereby, in a sense, synthesizing the "knowledge assets" of Aleph. The accuracy and reliability of this formula will be a valid measure of the distance separating us from the goal of semi-immortality. In fact, the identification of a reliable and objective measure of our psycho-physical state would not only imply a clear understanding of those mechanisms that, in probabilistic terms, may bring us closer to or away from death, but, most importantly, it would mean that we have precisely discerned whether a given behaviour has a positive or negative impact on our real situation.

One of the guiding principles of Aleph Vita is an active attitude towards risk and therefore it will be committed to sharing with the customer both the preservation of the psycho-physical efficiency and the involvement in the search for a positive solution in case of problems. This principle must be "measurable" in an objective way and display progressively higher degrees of accuracy and reliability. Each error, just as each new discovery, should lead to a refinement of the formula. Similarly, every recommendation concerning lifestyles or specific treatments must be quantitatively confirmed, not only in general terms, but, primarily, in particular terms, namely with respect to the individual person. This should, at least, result in the minimization of the risk of treating "an organ" rather than "a person", which, from the standpoint of semi-immortality, would be a particularly detrimental strategy".

Notwithstanding that every person should be free to do whatever she wants (at worst, paying an exceptionally high policy premium or, in very extreme cases, ceasing to be insurable), Aleph Vita will also have the institutional task to indicate to the customer what behaviours are, in terms of probabilities, expected to improve her psycho-physical efficiency, thereby increasing her life expectancy and, as a consequence, allowing her to pay a lower annual policy premium. To achieve this outcome, the client will have access to a variety of services related to the policy. As we have repeatedly stressed, semi-immortality is an extremely complex goal to achieve, it is not even conceivable to think that we might become semi-immortal (or, however, manage to indefinitely extend our life span) in a "passive" way, leaving all decisions to others. Hence, this range of services will have the fundamental role of providing information and tools to support decision, most notably the critical tool of "being able to decide". Also in this case, we can repeat the point made earlier with respect to the availability of selected information: so many were the times when our laboratory of psychoneurophysiology succeeded in uplifting a situation that seemed hopelessly compromised through the "simple enhancement of the reasoning (and hence the decision-making) mode of a patient!

17.3 A path that will last throughout the next 30 years at least

In the summer of 2006, on a Sardinian beach, a fully clear sky saw a lightning strike and kill a young boy who was peacefully sunbathing with his girlfriend[155]. This kind of events, in a sense, is to our semi-immortality-based philosophical approach what the irrationality of the diagonal of the square was to the Pythagorean school[156]. Nevertheless, we will not kill any journalist for publishing the news... and we are onfident that it will become part of the material taught in future elementary schools, just as today's pupils are taught the existence and use of irrational numbers. From the standpoint of the society of semi-immortality, and of Aleph in particular, this class of events is particularly useful for it serves as a reminder that the path ahead is still a long one.

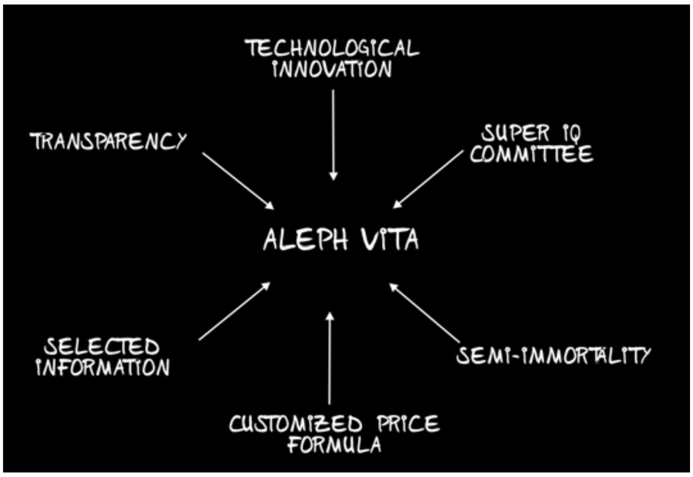

Fig. 17.1. Aleph Vita.

Aleph Vita will see the light when the "pricing formula" becomes sufficiently reliable. Here, we are referring to an adequate reliability to start, but certainly not yet to provide an accurate, error-free measure of the actual psycho-physical efficiency of a person. In fact, many years will have to elapse from the time of departure before the formula might reach a real predictive value at the level of the individual customer. Aleph Vita is based on a twofold bet, namely that, on the one hand, the formula will indeed be sufficiently reliable to be used in probabilistic terms (here, we again encounter the law of large numbers) and that, one the other hand, in line with the content of this book, the upcoming technological innovations will progressively bring us closer to semi-immortality. Again, we can speak of a path that will last at least thirty years and, at the end of the day, the primary purpose of Aleph is to represent a tangible (and hopefully efficient) practical application of the ideas underlying not only our book, but also the work of hundreds of researchers who, like us, believe that semi-immortality will be attained by the end of this century.

[148] There is a fact that certainly hasn't slipped the attention of the lovers of symmetry as well as of the attentive readers, namely that also the sixth area is symbolically represented by a project. At the end of the day, what is this book if not the first real point of contact with the outside world?

[149] Demagogy (and thus any popular consensus that is built on demagogic foundations) is one of the greatest obstacles to semi-immortality. Politics (and hence the management of the public assets) rests on messages which can only be brief and are characterized by the physiological need to be "against" something or someone. There is nothing particularly surprising in this analysis, and, at present, democracy however provides us with the most fertile ground for the development of truth and individual freedoms. Nevertheless, there must be a remarkable qualitative (and cognitive) leap before any form of "centralized power" may be considered as an ally and not as an obstacle.

[150] Our representation model of mental processes suggests that prevalently "analogical" people tend to favour their own work and they find ir difficult to detach themselves from it, whereas mostly "realizational" people are more impartial with respect to their work and, once it is accomplished, they have no particular problems in leaving it behind. Each "creative" reader (who is therefore endowed with a significant analogical component) may rely on this simple law to self-evaluate her dominant mind type with a good degree of accuracy.

[151] In our opinion, the only crucial problem is that the current normative framework fails to provide for the actual possibility of setting up an insurance company where the customers are also the shareholders. Actually, there exists the legal form of the mutual insurance company (where all the policyholders are shareholders), but the main directing body is inspired by "democratic" logics (one person, one vote, regardless of the capital invested), resulting in a situation that, in practice, irreparably undermines the possibilities of effective management. Under European law, a life insurance company would require a capital of 2,5 million euro to be established in the form of mutual insurance company. Even assuming a policy cost of two thousand five hundred euro (which is a considerable sum of money), we would have a ratio of 1 to 1000 as capital invested and, in the best scenario, a ratio of 1 to 5 as voting rights in the assembly. Therefore, the requirement to a priori establish a guarantee fund today

makes the mutual insurance company an impracticable option. And, in fact, they no longer exist.

152 "The Aleph" by Jorge Luis Borges narrates the story of a writer who is convinced that there is an Aleph in his basement, namely an artifact slightly larger than three centimeters in diameter which is able to encompass the infinity. The power of this symbol is so vast that it could well be regarded as the Symbol par excellence. The Aleph is everything and nothing at once, it is "one of the points in space that contains all other points", "the place where all the places of the earth meet, without getting mixed, seen from all angles". Anything inside it can be infinite things: it is the wholeness that contains itself and all the singularities. Literally, it means zero and it is derived from the Hebrew alphabet (of which it is the first letter). Furthermore, the Aleph-zero is the smallest conceivable transfinite number, the starting point and destination of all things, what everything tends to; in a nutshell, what many religions refer to as God. Perhaps, to put it in our language, it may symbolize the only necessary support to describe the real; the only a priori which we need to resort to in order to minimize the contradictions. The first space and the first rule at once.

153 The first references to the *Lloyd's Coffee house*, which was owned by Edward Lloyd and located in London on Tower Street, date back to 1688. Throughout those decades, London had witnessed the progressive diffusion of coffee on the one hand, and the resukting need for marine insurance on the other. Edward Lloyd built himself a solid reputation by providing the Londoners with a place that was able to address both of these needs. A merchant who wanted to insure his vessel could ask an agent (a broker) to find one or more people willing to cover the risk of shipping: the better the investors he is able to mobilize, the better the broker. The coffee house became the place to go for anyone who was looking for first-hand, reliable information about naval expeditions at a time when communication was difficult. It seems that there already was the circulation of a bulletin printed by the owner and giving account of all the interesting news. "Lloyd's" rapidly became very well known in London as the venue where it was possible to underwrite marine insurance. In 1769, some of the coffee house's most illustrious customers decided to establish "New Lloyd's Coffee House" near Pope's Head Alley; nevertheless, it soon proved to be too small to accomodate the growing needs of the market. Therefore, two years later, 79 between brokers and customers agree to pay a subscription of one

hundred pounds, thereby opening a new phase in teh history of Lloyd's: the underwriters became the owners and the "First Commettee of Lloyd's" was established. In the following century, the coffee trade disappeared to make room for the more profitable insurance market; over the years the marketplace was strictly regulated and the *Committee* gained increasing decision-making power. In 1871, an *Act of Parliament* defined the legal foundations of the company. Today, the Lloyd's of London is the world's greatest company operating in the insurance industry. The last decades have not corroded the philosophy that has been governing the company throughhout tree centuries: unlike the other major players of the sector, the Lloyd's are not a company, but continue to be a market. On a practical level, this means that it is never the Lloyd's that underwrite insurance contracts:the company sets the rules of the market and provides centralized administrative services for its members who stipulate contracts. From a conceptual standpoint, not really much has changd as compared to the *Coffee House* of three hundred years ago: the brokers search the market to find the best deal for their customers. The members of Lloyd's are in competition with each other to offer customers the most efficient solutions, they typically form (temporary) syndicates that specialize in certian insurance sub-sectors (marine, airline, natural disaster insurance, etc...): these underwriters are known worldwide for their ability to cover any type of risk quickly and efficiently, by stipulating contracts ranging from the airline companies, major sporting events, banks, drilling plants and celebrities' body parts. While historically related to the insurance company, the *Lloyd's Register* is a marine classification company: in a nutshell, it certifies that the ship that may prospectively be insured (perhaps even through the Lloyd's) is in perfect conditions and complies with all the safety standards for navigation. The first and the oldest company in this sector is the *Register Society* which was founded in 1760 by a group of customers of the Lloyd's Coffee House; four years later, there was the publication of the first *Register of Ships*, a document providing both insurers and merchants with relevant information about the conditions of the merchant vessels they might invest in. The importance to secure areliable classification of vessels should not be underestimated: if a boat in very poor conditions is guaranteed as safe, the insurer might unknowingly embark on an extremely risky venture, paying a ship that fails to comply with the standards for navigation as if it was new. Beyond their historical and cultural ties, the insurance company and the classification company are formally separated.

[154] Only in recent years, some insurance companies have begun to employ a few parameters that (by chance) possibly correspond to extra charges, for instance smoking and obesity.

[155] We human beings may put ourselves in unreasonably dangerous situations and get away with it or we may not be so lucky. In both cases, however, there seems to be a sort of "cosmic order", at last from a probabilistic point of view. Then, there are those cases where individuals exit the game without any, so to speak, acceptable reason. On July 25, 2006, shortly after noon, Luca Marsala was suddenly struck by a bolt of lightning in a clear blue sky while he was quietly lying in the sun with his girlfriend on the beach of Nola, in Sardinia. The physical phenomenon is rather simple. There are particular types of storms that develop after a prolonged period of good weather which causes temperatures in the lowest layers of the atmosphere to rise, thereby favouring the accumulation of humidity. These types of storms are referred to as "heat" thunderstorms and their characteristic unpredictability make them particularly dangerous. In fact, there seems to be a complete lack of warning signals: the sky remains clear until the explosion of the thunderstorm when the lightning appears. After its formation, the lightning tends to follow the path with least electrical resistance between the cloud and the ground: anything that heightens from the ground shortens this path, becoming a potential target. Within a context of semi-immortality, the experience of a bolt of lightning in a clear sky sounds a bit like a mockery: sometimes, the everyday efforts to minimize our mistakes, the varyingly accurate predictions of the risks that should be avoided with the ultimate goal of extending our stay in the game as much as possible, seem to be not enough. Inexplicably, "irrationally", in a beautiful sunny day there comes a stupid lightning that suddenly strikes you. *Game over.*

[156] What in a certain time period might have stirred up a scandal, over time, has developed into a matter of fact, something obvious, nevertheless, there is a sense in which it is correct to say that its conceptual dramatic nature has remained unaltered. More than two thousand years ago, in the Greek Pythagorean school, a mathematician named Hippasus of Metapontum discovered irrational numbers (i.e. numbers which cannot be written as a fraction and which have an endless expansion in any base) while trying to represent the square root of 2 as a fraction. Hippasus gave the first proof of the incommensurability of the side and diagonal of a square (two segments L and D are commensurable when they

have a common submultiple, namely when L and D are multiples of the same segment). In a few words, the length of the diagonal is not expressible as a multiple of the length of the side and nor as a fraction of integers. This caused a huge scandal and, according to the legend, the tragedy culminated with the drowning of Hippasus. The Pythagoreans believed that the whole universe was made of integer numbers, that is uncorrupted (i.e. unbroken), therefore sacred, entities..The world was entirely based on simple ratios between them. This is why the discovery of the existence of quantities that cannot be expressed as fractions of integers represented a threat to the entire project of explaining reality only in terms of numbers and it inevitably broke the cosmic order that had always been an absolute and unquestioned principle.

18. Functional diagnostics

The first case of a person who has benefited from our systemic approach to psycho-physical wellbeing dates back to 1992. Since then, we have never ceased to investigate the true nature of the active principle of the mind-body connections and, at the same time, we have constantly tried to make the results of our researches available to whoemever might need them. There is an internal committee that is responsible for financing not only the researches in the medical-psychological area, but also the assistance for patients who cannot afford even the small fee we charge for our operations. Besides the financial resources offered by our businesses, this committee can also rely on the funds received from a few external private organizations (typically, foundations that are concerned with bringing together patients who suffer from specific diseases) which recognize the usefulness of our approach.

After catching some glimpses of what we believe to be the field of operation of the active ingredient in the healing processes, namely the area of self-reference, there emerged the problem that, in our opinion, must be tackled and solved with the utmost urgency: the identification of an as objective as possible measure of a person's health status or, in more precise terms, of the efficiency level of each specific functionality of the “system man”. This will be the only way to measure the effectiveness of a given treatment in terms of a real extension in life expectancy and to discriminate between a a temporary progress and a structural adavancement. In accordance with our approach, we think that several systems (cardiovascular, immune, endocrine, etc...) are at work within a person and that, besides being endowed with self-regulation mechanisms, they tend to reciprocally compensate each other. Too many times have we observed the positive impact of a therapy on the efficiency of a given system be accompanied by a detrimental effect on the efficiency of another one. Moreover, we think that only an adequate system of objective measurement will enable us to identify the connections between mind and body and thus to employ medicines such as "word" and "reprogramming of thoughts and lifestyles" in a rigorous and reproducible manner.

The issue of measurement adequacy is a problem of huge import. In the portfolio of the projects we are currently working on, this is undoubtedly the most demanding one in terms of time and resources, and it is the only undertaking that might be found to lie beyond the reach of our capacities. Today, there are several diagnostic methods aimed at evaluating our health status, including the well-known biomarkers in blood[157], the latest tools based on the detection of the radio waves emitted by the cells[158], and all those new discoveries that every day enhance the efficiency of consolidated methods such as the EEG[159].

From our standpoint, the main flaw of the current system can be identified in the lack of a univocal approach to evaluate the data objectively. As a matter of fact, except in extreme cases, it is virtually impossible to come up with a somewhat reliable prediction of our state of psycho-physical health in six months, let alone to forecast the a priori effectiveness of a given therapy on an individual therapy. Both medicine and psychology are still, in all respects, arts and not sciences: data are interpreted according to the therapist's sensitivity and experience and a substantial part of medical intervention is primarily based on trial and error. The qualitative differences in the results delivered by a good therapist and an ordinary therapist are staggering: it is difficult to identify other disciplines where the human factor plays such a decisive role as in medicine and psychology. In addition to these trivial observations, we may note our society's tendency to depersonalize the various therapeutic relationships, and all this points to the daunting methodological backwardness that we are still forced to live with. And we are speaking of one of the four key pillars that are supposed to take us to semi-immortality. The way will be really hard.

If it is true that the current diagnostic approach is, at best to "handle with care" in presence of full-blown problems, it becomes close to being unusable in a perspective of prevention. A substantial part of the outcome of the game of semi-immortality will depend on the preparation of our mind-body system with respect to the occurrence of dangerous events that might happen to anyone in the course of life. The attack of pathogens, prolonged exposure to stressful situations, accidents, traumas: all these are inevitable situations and they will probably remain so for a very long time. The solution we propose is not much to take all possible measures to avoid such situations (in most cases this would mean to give up living), but rather to equip ourselves so as to manage them the best we can.

Although much could be said about this subject, the purpose of this book is not to "get angry". Let it suffice to evoke here any reader's personal experiences with her direct or indirect realationshps with the domain of medicine and psychology. Each one of us has his baggage of anecdotes regarding mistakes made by therapists who were plainly superficial ot too complacent about prescription drugs[160]. This book aims at proposing solutions that are grounded on the observation of reality without any prejudice. No one may benefit from hiding the fact that today, when one is hospitalized, the probability that the health of the individual will deteriorate is very high[161] or the fact that pharmaceutical companies too often alter the data on the real usefulness of drugs (when they do not deny the dangers altogether)[162]. But there is no good either in ignoring the remarkable advancements of medicine and psychology over the last century. On the contrary, that will be an excellent departure point.

18.1 The cell

Our journey begins with the fundamental building block of the system man, i.e. the cell[163]. We are composed of cells, almost exclusively. Each cell has within it the instructions that regulate its functioning, both in individual terms and in relation to the other cells. Each cell lives and interacts with the environment in accordance to the physical (and therefore chemical) laws. Our theory of the models of reference conceives the cell as the first elementary unit to which the concept of "system" can be safely applied (we might perhaps proceed to further lower levels up to the atoms and beyond, but, for the time being, we have insufficient information to interpret such step).

The cell is our basic system. It has "perceptions" (it becomes aware of what surrounds it), it has "thoughts" (it is able to make decisions and it is endowed with memory) and it is capable of performing "actions" (it can modify the surrounding environment). The cells aggregate to form organs, organs aggregate to form functional systems, and in turn functional systems aggregate to form man. Everything is interconnected, interacting and everything is self-controlled. According to our approach, both the neat separation between organs and functional systems and their accurate identification are completely arbitrary. There exist the cells (which are different at each instant both in numerical and functional terms) and there exists the person who is composed of the whole aggregation of the cells. Again, we consider also these two aggregations, which are

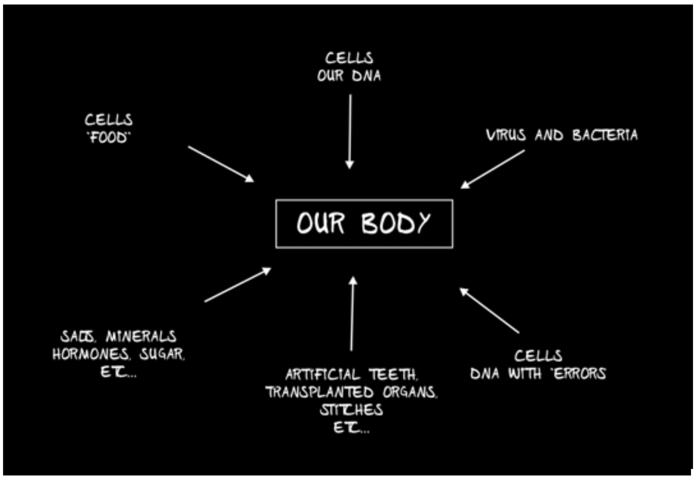

Fig. 18.1. "Our body".

at the extremes of the dimensional spectrum, as totally arbitrary: namely, these are not absolute distinctions, rather they are useful aggregations as they enable our mind to conveniently relate with reality (and thus to observe, to think and to modify it).

Speaking of the arbitrariness of systems, let us suppose to enter a room after conveniently taking off various clothes and adornments. In this room there is a special photographic equipment that is able to identify, with the highest degree of accuracy possible, the material which what we usually call "our body" is made of. First of all, we will detect our cells that can be identified thanks to DNA. Now, let us suppose we can filter the image, thereby excluding these cells. We would be left with a myriad of other cells, namely those of bacteria and viruses within our body[164]. Let us assume we can identify all the types of bacteria and viruses, thereby leaving them out of the image as well. At this point, there would remain a few other cells, similar but not identical to those of our DNA, these are the so-called cancer cells. A healthy person will exhibit only a limited number of cancer cells, whereas in a sick person they might be spread throughout the body. Let us suppose we can remove also this kind of cells from the image. Would we still see something? Absolutely. We would observe the dead cells of ingested but not yet assimilated food and a substantial amount of inert material, namely a mixture of salts, minerals, hormones, sugars, etc... But even this is not the end of the story, we would see a possible artificial prosthesis, as well as a a transplanted organ (which would obviously be composed of a DNA different from ours), suture stiches, a ceramic tooth, the blood acquired through a blood transfusion, etc... This is what we call "our" body.

Now, let us turn the super-technological equipment off and switch another one on, perhaps even more sophisticated, i.e. one that is able to measure the metabolic variations of the whole organism: the number and location of cells (subdivided by type), bacteria, viruses, cancer cells, salts, hormones, etc... So we switch it on and we notice that, instant after instant, the number and location of the cells constantly change, and, at certain times, even very significantly. A few minutes later, the same tiny door we used to enter is crossed by a ferocious and furious lion. Let us take a look at the values! Then, there enters a beautiful huntress (or a handsome hunter) who kills the lion, takes the clothes off and comes towards us. Let us take a look at the values! This is what we call the effects of our mind on our body.

We will achieve semi-immortality when we attain a thorough understanding of the relations subsisting between the various cells of the body, their dynamics in relation to the external agents (bacteria, chemicals, etc...) and how our mind interacts with them. In other words, we will be able to indefinitely extend our life when we manage to comprehend the functioning of the cells from a genetic, environmental and self-referential standpoint. And the first step is precisely the identification of a method to measure their efficiency.

While we wait for the super-technological machine specialized in measuring the causes, at present, the most viable way seems to be the measurement of the effects, namely the actual functionality of the various subsystems. If an immune system is able to defeat any kind of infection, then it can be reasonably regarded as better than one that falls sick continuously. By the same token, a cardiovascular system allowing an individual to effortlessly climb up ten floors of stairs can be considered better than one that results in short breath after just three steps. Just as we can acknowledge a digestive system that is able to assimilate any type of food as more efficient with respect to one characterized by several food intolerances[165].

As far as the functional systems are concerned, we may look at the system man from several points of view, but here we deem it useful to consider the subdivision that emerges when we adopt an evolutionary standpoint. Starting from inorganic matter, at some moment in the history of our universe, and in some still unknown manner, there was the appearance of what we like to call "permanence of information": namely the first viruses and the first bacteria appeared. We may, perhaps figuratively, imagine that at this point a sort of "clash of information" occurred. A few cell (strictly single up to that time) tried to coordinate with the respective daughter cells, thereby probably producing a modification in the information so as to provide for such possibility. That marked the beginning of the appearance of the first multicellular organisms. As we proceed along this scheme, the first functional level we encounter is the energy level[166], immediately followed by the immune[167], the "repairing"[168] and the reproductive[169]ones. First of all, each cell, or the organism composed of multiple cells, must be able to feed itself. Then, in a perspective of "vicory of one's own information content", it must be able to reproduce and to

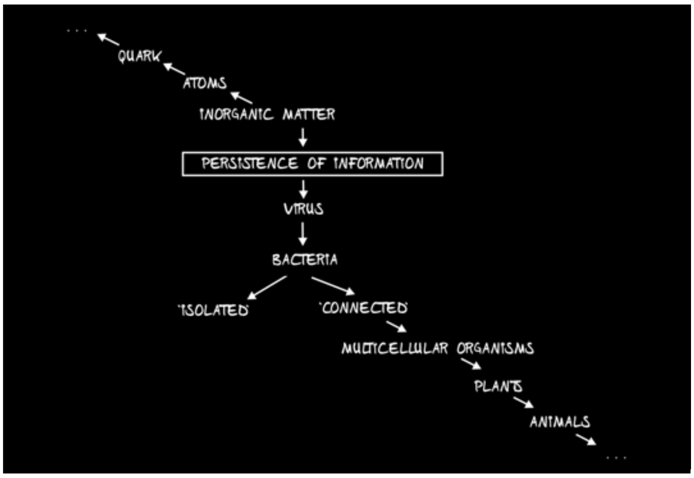

Fig. 18.2. The rise of the permanence of information.

defend itself from the attacks and to self-repair in case of damages.

As the complexity of the organism increases, it becomes necessary for it to be endowed with the endocrine system[170] (to enable the communication among the various cells even at a distance), with the "distribution" system[171] (to feed also the internal cells) and with the skeletal system[172] (to enhance resistance against external agents). Of course, at each subsequent formation, the new subsystem will be able to rely on the previous systems and these can, in turn, exploit the full potential of the new systems.

As the complexity of the organism grows further, we will observe the formation of higher functional systems, namely those related to perceptions (the sensory system[173]), those related to thoughts (the nervous system[174]) and those related to actions (the muscular system[175]). All previously existing systems are reused and, when necessary, improved (for instance, the lymphatic distribution system is integrated and enhanced by the cardiovascular system). Obviously, each living form has its own path and its own evolutionary dynamics, nevertheless we believe that the essence of the scheme we have just described applies to any individual on Earth which is endowed with DNA (be it animal or plant).

Before continuing, we would like to discuss the implications of the reuse of the previously existing systems on the system as a whole. For example, in mammals, the cardiovascular system not only performs the task of feeding all the cells in the body (which is probably a primitive function), but it is also involved in the transmission of hormone messages, the reparation of damaged cells, the defence against bacterial attacks, etc... These functional reuses are probably very efficient in terms of construction and compensation, nonetheless they are one of the reasons of ageing and, most of all, the main obstacle to all our attempts to intervene. For example, when we introduce into our body a substance that, on the one hand, can be beneficial to a certain part (i.e. might improve the efficiency of a given functional system), and, on the other hand, might be detrimental to another part (i.e. might be harmul for another functional system). These consequences could be easily identifiable, and thus predictable, if the systems were sufficiently separated from one another (for instance, a painkiller that acts on the stomach acids actually eases the pain, nut it might also damage the stomach lining). Nevertheless, as we have seen, the systems constantly overlap, therefore, too often, the treatments based on exogenous interventions may end up not only producing side effects that are more detrimental than the original symptoms, but also damaging the same system that they were to repair (such as certain antideprassant drugs that interact with both the endocrine system and the nervous system itself)[176].

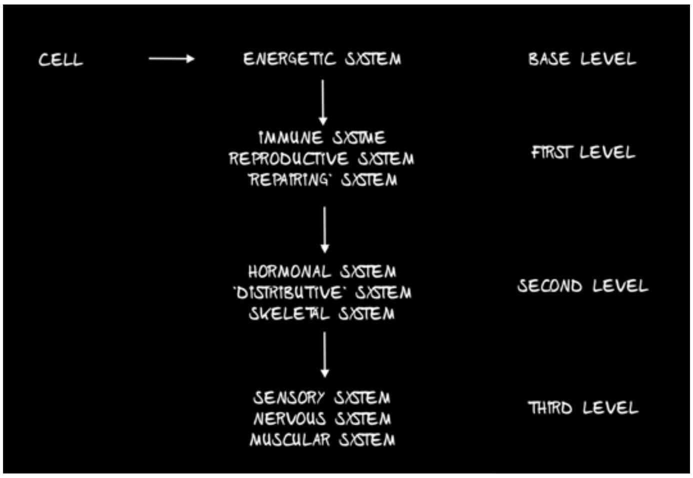

Fig. 18.3. Evolutionary rise of functional systems.

18.2 Measuring the body

According to our approach, each of the system under consideration may be measured in terms of functionality. Furthermore, from the standpoint of verifying the performance of a treatment, or in preparation to semi-immortality, no system should be neglected. Measuring efficiency is far from being an easy task, however we think we should reasonably rely on three basic principles: potency, sensitivity and energy efficiency.

Potency may be interpreted as the maximum possible level of efficiency, the "stronger" a system is, the higher its chances to survive. However, potency alone is not enough, since the system also needs adaptive capabilities, namely it must be able to modulate its potency according to requirements, hence it must be endowed with a sensitivity that maximizes the "range

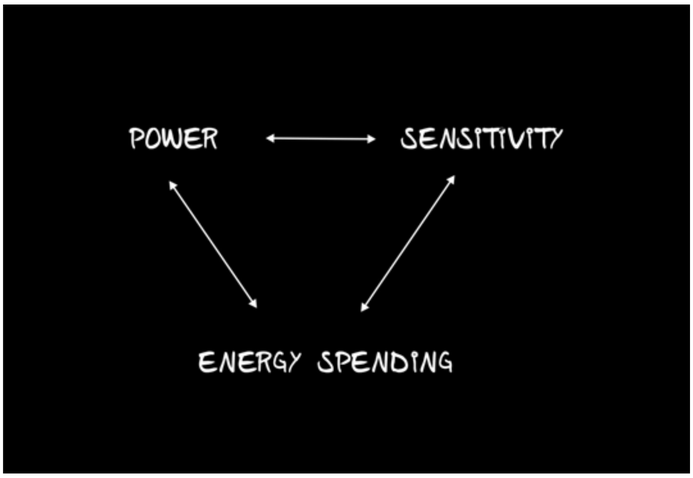

Fig.18.4. Potency, sensitivity, energy efficiency.

of operational possibilities". Finally, from the perspective of process optimization, the system must also be able to consume as little energy as possible (namely, to identify the most convenient routes in terms of available resources). These three factors are closely interrelated (for instance, higher potency necessarily requires a higher energy supply) and they all must be taken into account in the phase of measurement. This interpretative key is directly derived from our model of the "three minds": in fact, potency can be associated with the logical mind, sensitivity is related to the analogical mind and energy can be connected to the realizational mind.

Furthermore, consistently with the fractal properties of the models of reference, these principles can be applied at any scale level: cells, organs, functional systems, individuals. As an example, let us consider one of the most important and studied organs, namely the heart. As we all know, the heart is a "pump", therefore its power may be measured in terms of its ability to pump blood, obviously with respect to the exigencies of the individual: a woman who weighs 40 kilograms has different needs than a man who weighs 120 kilograms. As far as the heart is concerned, a weight of one hundred and twenty kilograms is not “bad” per se, but it becomes so if the heart is not able to pump blood effectively. Similarly, the heart must be able to operate under any circumstances (in the sense of heart rate, i.e. the temporal distance between one contraction and the next). It would appear that the heart makes use of distinct muscle cells according to different frequencies and that it tends to constantly vary the cells involved so as to keep them “well-trained”. Thus, the analysis of the spectrum of the heart rate allows us to evaluate the elasticity of the heart and whether it is ready to adapt to any situation. Finally, let us address the issue of energy consumption. Here, the discourse about measurement becomes more complex: at present, we are not able to directly measure the quantity and quality of the resources needed by the heart for its operations, nevertheless, we may try to assess its tendency to rest in situations of lack of work, for instance, measuring the recovery time after a run, rather than the number of heartbeats in a situation of relaxation. Unlike the two previous measurements, that of energy efficiency is an indirect measurement, but, as far as we know, currently there are no alternatives[177]. If we extend the example of the heart to any other organ or functional system, we may begin to obtain the measures that are so essential to our path. Some of these measures will still be imperfect (or excessively indirect), however we believe that the way is open.

18.3 Measuring the mind

If it is true that the current measurement systems of the body, albeit fairly objective, are not easily interpretable, it is equally true that those related to the mind, besides being difficult to evaluate, are also far less objective. First of all, compared to physical abilities, mental faculties are more prone to be affected by possible contingent problems and the emotional component of the individual: it is extremely complicated, if not impossible, to take all the relevant variables into account. For example, if the context is perceived as somehow "unlikeable", then our mind tends to "snub" the questions being presented, thereby distorting results: the "best" appear as the "worst" and vice versa. Not to mention the test class that is based on direct questions such as. "how are you today"?, "have you ever had obsessive thoughts?", etc... From the standpoint of semi-immortality, these are all examples of serious methodological flaws. In measuring the mind, we will adopt the same functional principle underlying the measurement of the body. The stronger, more flexible and efficient the mind is, the finer we expect it to be. It is reasonable to assume that the ability to cope with any kind of situation is more desirable than the fear of leaving the house. Just as it is more desirable to have a good memory, a fine sense of direction, the ability to learn any task quickly and to understand any concept in its essence, etc... In spite of the obvious difficulties, the importance of being able to measure the mind should be sufficiently clear: any enhancement of physical efficiency results in the enhancement of mental efficiency and, symmetrically, any enhancement of mental efficiency determines the enhancement of physical efficiency[178].

The nervous system can be seen as the main functional subsystem that connects the macrosystem body to the macrosystem mind. We deem it probable that all the connections between mind and body (and vice versa!) do pass through the nervous system either directly (brain, nerve transmissions, etc...) or indirectly (endocrine system, energy system, sensory system, etc...). This is the reason underlying the adoption of the term "psychoneurophysiology" within our laboratory to denote both the "science of medicine" and the "science of psychology". And this same reason led us to believe that it is not possi-

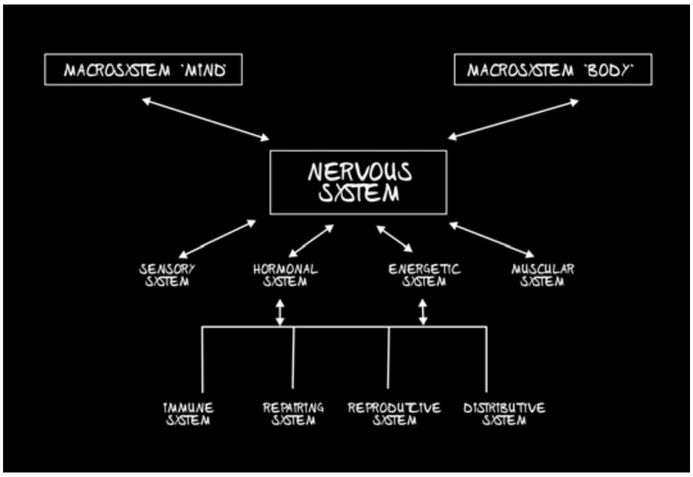

Fig. 18.5. "Psychoneurophysiological" system.

ble to separate the two fields of research[179]. The nervous tem can also be conceived as the initial hardware endowment of our mind. Conversely, the software endowment is not fixed, but it is composed of all the models of reference that are inscribed within our genetic code (initial endowment), the models of reference acquired through experience (environmental influence) and the models of reference developed by means of will and reasoning (self-referential abilities). All hardware conditions being equal, the overall quality of a system will obviously be determined by the quality of the software. By the same token, all software conditions being equal, the overall quality of a system will obviously depend on the hardware resources available[180].

A possible example of measurement of the nervous system from the standpoint of the mind, thus "active" with respect to the execution of a certain task, is the maximum number of iterative actions that can be performed in a given time period (for instance, the number of finger tappings on a plate), rather than the minimum time necessary to carry out a specific task (for example, the number of tenths of a second it takes to activate and deactivate an electronic chronometer, again with a finger). Notwithstanding all fundamental precautions, thinking in relative terms[181] (the same individual over time) and not much in absolute terms (the individual compared to other individuals), these measurement examples might be extended to the whole range of functions of the nervous system[182].

As far as the measurement of mind itself is concerned, our opinion is that a game-based approach is particularly useful. Choosing the appropriate figure to complete a matrix of other figures, playing chess, or a videogame are activities that allow us to undertake a preliminary measurement of the evolution of an individual's mental abilities. The computer often becomes an ideal game companion to challenge. There is no direct feedback, the influence of the environment is limited and the play aspect should serve as an incentive to exercise some "effort". In our research laboratory, we have examined and developed sevaral games with the specific intent of measuring a person's mental faculties. First and foremost, we have to clarify that this is an extremely complex task: the motivation component is very difficult to filter out and, as already mentioned in a previous section of this chapter, it has the undesirable characteristic of distorting results. Nevertheless, a few considerations can be formulated.

Logic games (such as chess and Go) are an excellent means to measure some functional subsystems of an individual. Of course, they are affected by specific experiences, but, when filtered through appropriate algorithms, they are sufficiently reliable. We think that a satisfactory degree of reliability to measure other mental modules can be found in photographic memory games, rather than matrix completion exercises. We can reasonably assert that there are now a few fairly reliable tests, provided they are administered in a generally neutral way and using only considerations of a relative rather than absolute nature. The problem is that the so-called "set-piece" tests are excellent tools to measure those mental subsystems that are related to the hardware and the logical mind (the various types of memory, the speed of reasoning, the number of different thoughts that are simultaneously manageable, general intelligence, the speed of learning, etc...), but they are poor instruments to measure the subsystems related to the analogical mind and practically ineffective with respect to those related to the realizational mind. From the perspective of semi-immortality, all this adds up to a major flaw. For instance, emotional intelligence, which is of the utmost importance for evolutionary purposes, falls in the domain of the analogical mind. And the ability to lead, which is of the utmost importance for personal success, falls in the domain of the realizational mind. Moreover, from the standpoint of therapy, we regard the analogical mind as the main source of inspiration and, from the viewpoint of recovery, we consider the realizational mind as the crucial tool to rely on. From all the discussion above, it appears clear that it is necessary to improve the current situation quickly.

[157]Haematic biomarkers are useful indicators of the psychophysical conditions of our body. It is particularly interesting to study some of these values' deviations from the standard values as they highlight a possible "pathological" condition with respect to a possible "normal" condition. It is easy to verify that the available tests are truly numerous by simply consulting the catalog of any specialized laboratory.

[158] It would appear that, during mitosis, the cells emit a faint glow in UV light, which can be detected by means of photomultiplier tubes and which exhibits the same features of a pulsed emission in the ULF and ELF frequency: such emission of light may be related to the cellular metabolism and the oxidation-reduction reactions taking place in the cytoplasm. Thanks to these cellular properties, the stimulation of tumoral masses with a Xenon laser results in the emission of a fluorescence spectrum which is similar to that of tumor cells that have absorbed HpD: the emission has two specific peaks at 630 and 690 nm and it would allow us to detect tumors whose size is in mm, or where tumoral cells are in the order of 10^6, namely three orders of magnitude lower than what is available with the current diagnostic imaging.

[159] It has long been a known fact that there exists a correlation between the brain and electrical phenomena: already in the year 1875, Richard Caton published an article on the *British Medical Journal* describing his findings about the electrical phenomena in the hemispheres of rabbits and monkeys. However, it is only in the Twentieth century that the pioneering work of the German physiologist Hans Berger laid the foundations of the technique taht today is referred to as EEG, namely the electroencephalogram. As it is well known, neurons communicate with each other through the exchange of electrical and chemical signals. In a concise manner, the electroencephalogram is the first non-invasive procedure that measures the electrical activity of the brain. EEG activity stems from synaptic currents generated by cortical pyramidal neurons, as a result of afferent signals from other cortical areas or from the sensory thalamus; it should be pointed out that the summation of the activity of many pyramidal neurons is required to give rise to detectable signals. There are four types of waves in an EEG tracing: *alpha*, *beta*, *delta* e *theta* waves; the usefulness of the EEG lies in the fact that any variation in the activity of these waves is systematically related to physiological and pathological events. *Delta* waves have a frequency up to 4 Hz

and are typically associated with the brain activity of very young patients; *theta* waves (ranging in frequency from 4 to 8 Hz) are related to childhood and adolescence as well as to particular mental states such as trance, hypnosis, daydreaming and the "preconscious" state that is experienced right before waking up or falling asleep. The frequency of *alpha* waves typically range from 8 to 12 Hz and is characteristic of a normal, relaxed waking state (normally, these waves can be better identified when the eyes are closed).*Beta* waves have a frequency above 12 Hz:this type of waves with low amplitude and variable frequency are typical symptoms of high concentration and active thinking.

[160] From our standpoint, the situation is fairly clear: medicine is far from being an exact science; furtermore, it is an extremely complex science which is characterized by countless interrelations and where errors are the norm and not the exception. It would be sufficient that all patients were informed of this simple fact and that doctors did not conceal it. This is why, in a perspective of semi-immortality, we deem it essential that the final decision should be taken by the patient rather than the doctor (except, of course, all those cases in which timeliness is a pivotal success factor for the intervention). The doctor's role must be that of a "consultant" who clearly explains to the patient what the options are, who allow her to verify and delve into the various hypotheses, perhaps with the help of her family or of specialized companies, thereby enabling her to decide for herself.

[161] Several studies show that in many cases it is the "physician who shapes the disease": if you contact a neurologist, most likely, he will tell you that your disorder is of a neurological origin; orthopaedists, cardiologists and endocrinologists will be naturally inclined to other explanations. Unfortunately, the likelihood of being hospitalized, subjected to surgery or to a given therapy does not only depend on the patient's conditions, but also on the state of health care supply. For instance, according to the data reported by Joerg Blech in his book "The disease inventors", the number of otorhinolaryngologists in the town of Basel is three times that of the neighbouring canton of Grisons: the coincidence has it that in the former case almost twice as many citizens have undergone the removal of the tonsils. Therefore, therse operations are often unnecessary, but they rather serve the purpose of balancing the budget of physicians and hospitals, and this cannot but affect the quality of care. Each operation involves a certain percentage of risk that may result from human error, the possibility of

unforeseen complications, the general risks inherent to anesthesia. A study of the American Institute of Medicine focused on a medical phenomenon that has become almost a popular myth, namely the poor handwriting of doctors in filling out perscriptions. The research revealed that every year thousand of American citizens take the wrong medications because their pharmacists have misinterpreted the "squiggles" of doctors, with sometimes fatal consequences. However, it is the probability of infection that makes the hospital a truly risky place: several statistics seem to indicate that the percentage of patients who acquire an infection during hospitalization is of particular concern (i.e. almost certainly more than 5%).

162 Tens of thousands of medical studies are published every year, many of which are focused on pharmacology: research actually produces twice the results that are effectively disclosed, but these are silenced because they conflict with the interests of pharmaceutical companies. But how can this even happen? As effectively illustrated by Jack Law, nin his book "Big Pharma", in some respects, we are dealing with one of the oldest plots in the world: those institutions that are supposed to monitor the quality, safety and efficacy of drugs are funded by the same pharmaceutical companies, thereby creating a huge conflict of interests. This enormus industry is willing to continue to make profit, even at the expense of the health of consumers, the cases of Vioxx, of SSRIs and the drugs for ulcers are only a few examples of such policy. The first is a painkiller that was marketed in 1994 as a substitute for aspirin with lower intestinal side effects. A few years later, studies conducted by the manufacturers themselves unquestionally showed that the new drug carried secondary effects which significantly increased the risk of stroke and heart attack. It took four years before the drug was finally withdrawn from the market: throughout this period the results had been deliberately silenced via an intensive disinformative campaign. The case of SSRIs (i.e. seletive serotonin reuptake inhibitor) involves a much greater number of people. These inhibitors are essentially composed of six molecules, from which the respective drugs have been developed: Fluoxetine (Prozac), Fluvoxamine (Maveral, Fevarin, Dumirox), Paroxetine (Sereupin, Seroxat, Eutimil, Daparox), Sertraline (Zoloft, Tatig), Citalopram (Elopram, Seropram) and Escitalopram (Entact, Cipralex). These drugs, among which Prozac has been not only the precursor but also the most popular and widespread one, have had a large circulation as the producers claimed they were able to address a number of needs including panic attacks, depression, schizophrenia

and post-traumatic stress. Modern chemistry had managed to produce a panacea capable of restoring happiness, though failing to mention a few "details". Already at the end of the Eighties, consumers gradually became aware of some side effects that were not reported by the pharmaceutical company, such as addiction and suicidal instincts. Although these data are fairly known, the situation hasn't changed much, in fact, ten years later, these drugs are still regularly prescribed to a great number of patients all over the world. Finally, of particular significance is the case of the drugs for ulcers. Around the year 1984, a few pharmaceutical companies engaged in the production of drugs against stomach acid and efective in countering the effects of ulcers. Nevertheless, only one year earlier, an Australian researcher had identified and isolated the *Helicobacter pylori*, namely a bacterium that is the true cause of the disease. For over ten years, the "unaware" medical community had continued to tackle ulcers with symptomatic therapies, thereby exposing patients to unnecessary (and thus continuous …) treatments, when simple, targeted cycles would have allowed to permanently eliminate both the bacterium and the disease. It was only in the second half of the Nineties that the antibiotic treatments began to replace the symptomatic ones.

[163] *The cells*. The cell is the smallest unit exhibiting all the peculiar characteristics of life. This microscopic unit relies on the elements of the environment to synthesize nearly all of its components, thereby managing to grow and self-multiply. Hence, the cell is the smallest unit of an organism capable of operating independently. Let us consider a house under construction: the brick is the basic, repeated, minimum component of its structure; if we compare an organism, in its complexity, to a house, then the cell is the elementary unit that is repeated and performs several functions enebling the organism itself to live. The cells can display very different sizes and shapes. Bacterial cells are the smallest, inasmuch as their length is in the order of 1 μm (i.e. one millionth of a meter). The cells of animal tissues are extremely varied in shape depending on the type of cell and the task they are responsible for (they can be spherical, star-shaped, polyhedral, cubic, cylindrical, have irregular contours, etc...). The diameter is between 10 and 20 μm and the surface is characterized by a large number of introflections and eextroflections. For instance, nerve cells are roughly star-shaped and they have thin extensions which can reach several meters in length (such as it is the case for the nerve fibers innervating the neck of giraffes).Plant cells usually have a polyhedral shape, and their length is

between 20 and 30 μm; such regular shape is due to the fact that plant cells, unlike animal cells, feature rigid cell walls. All cells are bounded by a membrane (i.e. plasma membrane or plasmalemma) that encloses the cytoplasm. The cytoplasm consists of a semifluid material, i.e. the cytosol, which contains water, mineral salts and organic molecules and which is populated by several structures denoted as organelles, each serving a specific function. The cell membrane is a delimiting structure whose thickness is 8,5 nm on average and varies depending on the type of cell. According to the fluid mosaic model, the membrane consists of a phospholipid bilayer containing protein molecules and it performs the vital function of regulating the exchange of material into and out the cell. By means of "antenna molecules" on its surface, the membrane makes a selection of the substances that are allowed to cross it, except for water, oxygen and carbon dioxide which can cross it freely. Under the membrane there is the cytoplasm. The cytoplasm is a gelatinous substance primarily composed of water, which the structures of the cell are immersed in and several substances, including mineral salts and organic matter, are dissolved into. In the cytoplasm there reside the organelles: these are tiny structures responsible for the various functions the cells must perform: The cells are able to reproduce themselves: each of them divides into two daughter cells in a process called mitosis.. A cell's ability to divide varies depending on the category such cell belongs to. Three categories can be identified: cells that are subject to be continously replaced by new cells throughout the whole life of the individual, such as it is the case in the skin; cells that stop to divide themselves as the individual completes his growth, but which can however return to divide as a result of injury or trauma, such as it may occur in the liver and the thyroid; static cells that lose the ability to divide themselves even before the growth of the organism is complete. Some cells of the organism retain the ability to reproduce themselves throughout life and remain undifferentiated, hence they can give rise to different cell types: these particular cells are called stem cells. The size of an organism is not affected by the size of its cells, but rather by their number. The number of cells in a human being is 10.000 trilion, with a distribution of about 1 billion per gram. The overall number of brain cells (i.e. neurons) is approximately 100 billion (the equivalent of a 100Gb-disk). Most of our cells have an average life span of about one month. When a cell does not die as it is supposed to, but rather it continues to produce new cells and spread, we are confronted with cancer. On average, the onset of a malignant tumor occurs every 100 million billions of cell duplications.

[164] *Viruses and bacteria within the human body.* Viruses and bacteria are tiny, "microscopic" organisms, in the sense that they can only be seen through the microscope. Many bacteria normally live on the surface of our skin, in our mouth and our mucous membranes without doing us any harm, whereas others can cause serious diseases in humans. Antibiotics are the most effective drugs available against these bacteria. Viruses are even smaller than bacteria and they can only live and reproduce "inside" the cells of a living organism, be it animal or man, just as parasites. Viruses can cause both minor diseases ,such as colds, and more serious ones, such as measles. Antibiotics are ineffective against viruses, thus viral diseases require more specific drugs. It is therefore clear that billions of tiny organisms, including bacteria, viruses and fungi are around, as well as above and inside us. They are invisible yet omnipresent, extremely simple yet capable of taking countless shapes, minuscule yet potentially lethal. However, not all of these microscopic organisms are harmful, some even play an essential role in the complex human metabolism, as it is the case in the digestive process. In a perspective of semi-immortality, it should be emphasized that at present, we do not know with certainty whether microbes underlie certain diseases or not. Would you like a few examples? Only in recent years has the fact become established that ulcers is caused by a bacterium named *Helicobacter pylori* and not by stress as it was previously maintained. Other microorganisms are responsible for caries, and it has been recently discovered that even arteriosclerosis is induced by bacteria and viruses when the body lacks the protein interlukin-10. It would also seem that a very tiny nonobacterium, namely the *Proteus mirabilis*, may be the cause of kidney stones. The action of the microbes involved in the disease varies depending on the area in which the colony grows. For instance, staphylococci colonize the nostrils of one person in three, without causing any health problems. Another example is provided by the meningococcus which is harmless as long as it stays in the throat, whereas it is capable of causing epidemics of meningitis if it reaches the nervous system. As a matter of fact, if each bacterial colony in our body triggered a disease we would perpetually be in bed. Suffice to think that the skin of the armits contain at least half a million staphylococci per square centimeter, but they are literally everywhere in our body: on the jands they are 660 per cm^2, on the back 300 per cm^2, while the greasiest spots of the face, where pimples form, can harbor up to 4 million bacteria per cm^2 (anaerobic bacteria, such as the *Propione bacterium*). Only the microbes living on the skin of human beings amount to the incredible number of one billion

billions. Hence, our body provides an ideal habitat for billions of microscopic organisms that are equipped with their own genetic material (DNA or RNA), which "coexists" with ours. As far as pathogenic microbes are concerned, when our body is in excellent shape, it is extremely difficult for the microbe to generate a disease. On the contrary, it is virtually impossible. But when the body is in bad shape, the microbe wil begin to cause diseases. All the microbes are already there inasmuch as we cannot avoid them. The crucial point to understand is that under normal conditions they are dormant, but when they receive signs of deterioration of our body, they are activated.

[165] Using the yardstick of efficiency from the standpoint of semi-immortality is not so obvious as it may appear at first sight. For example, a few approaches assert that a sort of "controlled weakness" may indeed be a possible way towards the prolongation of human life (a typical example is a diet low in calories, rather than in sugars). Other approaches rest on the substantial deactivation of all those phenomena that may be detrimental to us: aseptic environments, the maximum degree of hygiene, no electromagnetic waves, generalized quiet, no stressful events, etc… Nevertheless, we have conducted several tests and observations in this direction, but the results have proved unable to fully convince us. Inasmuch as, for the time being, there is no conclusive evidence in either direction, we prefer to choose the path which is most consistent with our philosophical framework and which, among other things, is also the option allowing us to better appreciate the reality that surrounds us.

[166] *Energy system.* The cells host chemical reactions that allow them to grow, produce energy and eliminate waste. Taken together, all these reactions are referred to as metabolism (which derives from a Greek term meaning "transformation"). The reactions in the cell cannot occur in the absence of special catalysts called enzymes, which consist of protein molecules. The informtion necessary to perform all the metabolic activities of the cells, in other words the information that makes life possible, is contained within the the nucleic acids inside the cells themselves: deoxiyribonucleic acid (DNA) serves as a template for the production of ribonucleic acid (RNA), which interacts with protein structures called ribosomess to synthesize protein molecules. This leads to the formation of the enzymes which, in turn, allow the execution of all cellular activities. Cell metabolism is the set of all chemical reactions that occur in a cell. The orderly progression of these reactions, which is guaranteed by the presence

of cellular organelles, enables the cell to manage its own material and energy resources. The reactions that lead to the degradation of complex molecules to simpler compounds are defined catabolic reactions, while those resulting in the synthesis of large molecules are called anabolic reactions. The former release energy, whereas the latter consume energy. But what kind of energy is involved and how does it flow within living organisms? Living beings can use only two types of energy: the light energy emitted by the sun and the chemical energy contained in organic compounds. The light energy is used by autotrophic organisms, namely those organisms, such as plants, algae and certain micoorganisms, which produce their organic molecules from simple inorganic compounds, including water and carbon dioxide, which provide the eneergy necessary for their vital functions. The chemical energy is exploited by heterotrophic organisms (i.e. animals and most microorganisms).

[167] *Immune system.* There are a large number of pathogens that may be harmful to the organism such as parasites, protozoa, bacteria, fungi and toxins. Our defenses are divided into innate and acquired defenses. Innate defenses are nonspecific and they consist of mechanical barriers, certain types of white blood cells and proteins. Skin, mucous membranes and their respective secretions (i.e. sweat and tears) exclude viruses and bacteria from entering the body; monocytes, neutrophils and macrophages phagocytize bacteria, viruses and foreign substances; *natural killer* attack cancer cells and those infected with viruses; proteins (i.e. interferons and complement proteins) act against microorganisms either directly or by preventing their reproduction. The inflammatory response is a nonspecific response, either local or systemic, which helps to prevent the spread of the infection and it is our primary defense mechanism. During the inflammatory response, the cells release chemicals such as histamine which activate various defenses by increasing the blood supply to the infected area which brings additional phagocytes and other white blood cells that engulf bacteria. The lymphatic system is involved in both specific and nonspecific responses. Such system is a network of vessels and organs. Lymphatic vessels are responsible for drawing the interstitial fluid into the circulatory system. The orgains contain many white blood cells ready to fight infections when the lymph carries pathogens within them. The organs of the lymphatic system include the lymph nodes, spleen, tonsils, thymus and appendix. When the innate defenses are not sufficient to fight an infection the immune system comes into play; it consists of more than two trillions cells tht are present throughout the body in

the blood and lymphatic system.The immunity which is supplied by the immune system is called acquired immunity and it is highly specific, namely able to distinguish one pathogen from another. The activation of our immune system is induced by the contact with foreign substances called antigens.

[168] *Repair system.* All living organisms have developed systems that may be referred to as "repair systems" since they are responsible for intervening in case of damage, injury or partial loss. Some cellular and tissue districts can be regenerated either in part or wholly depending on the species and the degree of complexity of the organism. Some organisms, such as the starfish, can reconstruct parts of their body from a small portion. Any fragment of a starfish which contains part of the central disk can regenerate the missing parts, as it was realized by oyster farmers who used to capture starfish, which are formidable predators on oysters, cut each one into pieces and then throw them back in the sea. The starfish multiplied exponentially as the fragments grew into complete new individuals. A similar phenomenon occurs among vertebrates: a lizard whose tail has been cut can grow a new one through cell proliferation. However, the higher up the evolutionary ladde rone climbs, the less frequent repair systems at a macroscopic level become. The maintenance of the internal stability of an organism thanks to a system of regulatory and counter-regulatory processes activated by any departure from such equilibrium is termed homeostasis. It provides for the production of new cells and the removal of old ones, and it is one of the vital processes for every multicellular organism. In humans, there are several systems responsible for repairing damages resulting from trauma, or, in normal physiological conditions, for preventing any future damage or anomaly. The hematopoietic marrow is where all blood cells are produced and mature: red cells, white cells and platelets. It is also called marrow bone and should not be confused with the spinal cord. It is found in the inner spongy part of several bones including the vertebrae, skull, ribs, long bones of the arms and legs. In the spongy part, the hematopoietic cells are mixed with fats and other types of cells forming the stroma, namely the supporting and nutritive tissue of hematopoietic cells. From a perspective of semi-immortality, it should be pointed out that most cells are capable of self-destruction by activating an intrinsic suicide program, seemingly with the exception of highly specialized cells such as those of the heart muscle and the nerve tissue. This suicide program is called "apoptosis" or "programmed cell death". At a cytological level, apoptosis manifests itself as a condensation of the nucleus the cytop-

lasm. Subsequently, the cell fragments into several vescicles called apoptic bodies, which are rapidly phagocytosed and digested by macrophages or neighbouring cells. The cell disappears without a trace, that is without causing inflammation or necrosis. Cells are programmed to commit suicide if they cease to receive survival signals from other cells. This phenomenon is referred to as "*social control of cell survival*". It has been hypothesized that the induction of apostosis could be abolished though two distinct control mechanisms: the reduction in the activity of cell effector proteins on the one hand, and the increase in the activity of antiapoptotic proteins on the other.

[169] *Reproductive system.* Nature has provided living beings with two ways to perpetuate their species, namely asexual and sexual reproduction. In asexual reproduction only one parent is involved in the generation of genetically identical offspring by budding, division or fragmentation. Asexual reproduction enables an individual to produce copious offspring in a short period of time and with low energy consumption. On the other hand, sexual reproduction involves the production of gametes by two parents and their fusion through fertilization. Unlike asexual reproduction, sexual reproduction increases the genetic variability of the offspring. One form of reproduction is parthogenesis, in which an unfertilized egg develops into identical female offspring, as it is the case in rotifers (i.e. microscopic animals that live in freshwater environments all over the world). Parthogenetic animals resort to this reproductive option in times of environmental stress. Hermaphroditism instead is characterized by the presence of the gonads (and the organs) of both sexes in the same individual; fertilization usually occurs between two individuals. The human reproductive system consists of a pair of gonads (ovaries or testicles) for the production of gametes, a system of ducts that store and transport the gametes, and, finally, structures that facilitate copulation. The ovaries enclose follicles, each of which contains an undeveloped egg cell surrounded by one or more layers of cells that nourish and protect it. The follicles also produce sex hormones. Oviducts convey the egg cells to the uterus where embryos develops. The testicles produce male hormones, which are collectively called androgens, and spermatozoa that are expelled through the urethra after passing through the vas deferens and the ejaculatory duct. Several glands contribute to the formation of the fluid that nourishes and protects spermatozoa. Semen is the mixture of spermatozoa and glandular secretions. Spermatogenesis and oogenesis respectively produce spermatozoa and egg cells. The primary spermatocytes are continously pro-

duced in the testicles; these diploid cells undergo meiosis to create four haploid cells each. About every 28 days, a diploid primary oocyte that is suspended at the first stage of meiosis grows larger and completes meiosis I, thereby producing a secondary oocyte that is released from the ovary during ovulation and enters the oviduct where, only if fertilized by a spermatozoo, it will complete meiosis II and give rise to a zygote. The cyclical changes that occur about every 28 days in the ovaries and uterus (i.e. ovarian cycle and menstrual cycle) are synchronized by hormones. The hypothalamus stimulates the adenohypophysis to release both FSH and LH, which induce follicular growth and ovulation. After ovulation, a follicle turns into the corpus luteum which secretes estrogen and progesterone. These two hormones stimulate the proliferation of the endometrium (i.e. the internal lining of the uterus) that prepares to receive the embryo and inhibit the production of FSH and LH by the hypothalamus. If no fertilization occurs, the decrease in the concentration of LH is followed by the gradual degeneration of the corpus luteum.

[170] *Endocrine system.* The fundamental function of hormones is to coordinate the activities of the different parts of the body, enabling the various organs to operate in synergy. Hormones are chemical messegers that regulate a broad range of bodily functions such as energy expenditure, metabolism and growth. Hormones are produced by endocrine glands or neurosecretory cells, they are poured into the bloodstream and, in small amounts, they act on target cells even at considerable distance. The endocrine system often works with the nervous system which, in turn, avails itself of chemical messengers, i.e. the neurotransmitters, which carry the nerve impulse from one neuron to another. The endocrine system is a slow control system, whereas the nervous system is able to provide responses in the order of fractions of a second. Hormones act on target cells in two ways. Water-soluble hormones, such as insulin, bind to specific receptors on the plasma membrane of target cells and trigger a mechanism of signal transduction within such cells, thereby producing a change in the target cells themselves. On the other hand, fat-soluble hormones, such as testosterone and estrogen, penetrate into the cell by diffusion through the phospholipidic portion of the plasma membrane, then they bind to an intracellular receptor triggering the activation or deactivation of a certain gene. A hormone can bind to distinct receptors on separate target cells; thus, the same hormone can trigger different responses depending on the cell it acts on.

[171] *Distribution system.* The ability to make blood flow evenly throughout the organism in spite of the effect of gravity is a vital issue for all terrestrial vertebrates. All organisms need to exchange substances with their environment and distribute them within their body. Most animals have an internal transport system, i.e. the circulatory system, which carries oxygen and carbon dioxide, conveys nutrients to the cells and removes waste products of metanolism channeling them towards specific sites. The circulatory system contains a specialized fluid, ie. blood, which distributes essential substances to the cells and allows waste products to be conveyed to the excretory organs. In mammals, the capillaries form an intricate network of blood vessels between the cells of various tissues. Each cell is immersed in the interstitial fluid through which any exchange takes place. Many invertebrates, including most mollusks, have an open circulatory system; in certain regions of the body blood flows out of vessels and directly bathes the cells; vertebrates, including mammals, have a closed circulatory system, in which blood is enclosed in vessels and it is separated from the interstitial fluid. The circulatory or cardiovascular system is composed of the heart and a network of tubular vessels of different diameters. The arteries carry blood away from the heart while veins return blood to the heart. The circulatory system of fish is simple: blood passes through the heart (which is divided into two cavities) only once, it is pumped to the gills, where respiratory exchanges occur, then it passes to the rest of the body and returns to the heart. Both amphibians and reptiles have a double circulation (i.e. blood passes through the heart twice), yet an incomplete double circulation: the heart is three-chambered and, in the ventricle, the oxygenated blood is mixed with deoxygenated blood. The circulatory system of mammals and birds (which is both double and complete) is extremely efficient and it allows for a high metabolic rate.

[172] *Skeletal system.* Mobility is a peculiar characteristic of animals. Some motions are merely aimed at survival, such as that of a mouse running away to escape from a cat; other motions are functional to multiple daily activities, for instance eating or turning over the pages of a book. Locomotion is the active movement from one place to another, which implies an energy consumption to counteract friction and gravity. Swimming animals are supported by water, but also slowed down by its density, thus they gnerally exhibit aerodynamic shapes; walking animals usually jump and run in terrestrial environments, therefore they need increased support for the body against the force of gravity. Burrowing or

crawling animals overcome friction travelling by lateral wave movements or thanks to peristalsis. Finally, the wings of birds, bats and insects are aerodynamic and able to lift the body of the animal. Without a skeleton, animals would not be able to move and the majority of terrestrial animals would sag under their own weight; even acquatic animals would have no shape. Therefore, the skeleton is the support structure for the body of animals and it also serves to protect internal organs as well as providing the muscles with both support and resistance. The hydroskeleton or hydrostatic skeleton, which is typical of cnidarians and worms, consists of the internal body fluid. The exoskeleton is an external protective covering that is typical of arthropods: since the exoskeleton does not grow with the animal, it must be periodically renewed through the moulting process. On the other hand, the endoskeleton, as the human skeleton, is a wholly internal support structure.

[173] *Sensory system.* Salmons are agile and fast, yet they become an easy prey for bears when they are in shallow water. Despite its poor eyesight and its considerable size, the grizzly bear has lightning-fast reflexes and can catch a big fish like salmon with ease. What are these two animals linked by? How do they come to meet at a specific time in a determined place? Following its mother as a puppy and thanks to its sense of smell, the bear has learned to direct itself towards watercourses inhabited by salmons in autumn times. Conversely, the fish finds a sudden death at the end of a several-year-long journey, right when it was returning to its native stream to reproduce. Salmons rely on their highly developed sense of smell to follow certain smells and indentify a particular stream from thousands of other watercourses in the same area. In autumn, the female salmon lays her eggs in a bed of gravel at the bottom of the native stream; the male salmon fertilizes them and, shortly afterwards, both parents die. The following spring, the eggs hatch and the young salmons leave their streams to head towards the ocean, where they undertake a long journey. When they achieve their sexual maturity, they will return to their native watercourse, just like their parents. Salmons seem to find their way back to their birthplace using the angle of sun as a reference, but most of all thanks to their sense of smell. It appears that the water flowing from each stream carries a distinctive smell, a mixture of chemicals from the plants and soil of the area. The smell of its home stream become fixed in the memory of a young salmon before it moves to the sea: when the adult salmon reaches the proximity of its stream of origin, it keeps on swimming until it recognizes the scents that correspond to those

stored in its brain. Very few molecules of the substances present in the birthplace are sufficient to guide the salmon upstream. Some studies have shown that if the salmons' nostrils are plugged with cotton, they are no longer able to return to their birthplace. Sensory information gathered by receptors and processed by the brain guides both salmons and grizzly bears to certain areas of the river. Sensory receptors are specialized cells or neurons which detect stimuli. The energy of sensory stimuli is transformed into potential generators (gradual change in membrane potential due to a different ion flow resulting from the opening of certain ion channels and the closing of others) which trigger action potentials (i.e. the nerve signals carrying the impulse), which are transmitted to the encephalon. The action potential frequency is related to the magnitude of the stimulus. The repetition of stimuli may lead to a phenomenon of adaptation, namely a decrease in sensitivity to the stimulus that is repeated.

[174] *Nervous system.* The nervous system receives sensory information from both the external and internal environment, it processes this information and transmits the resulting directives to the expressor cells of muscles or glands, which implement the appropriate responses. Sensory neurons carry information from the sensory receptors to the central nervous system (CNS), which is made up of the encephalon and the spinal cord; the interneurons that are completely within the central nervous system are responsible for integrating the data received from the sensory neurons and then sending appropriate signals to the motor neurons; motor neurons transmit messages from the central nervous system to the effector cells. The peripheral nervous system (PNS) is outside the central nervous system and it consists of the nerves, all the neuronal fibers of motor and sensory neurons, and the ganglia which connect the cell bodies of neurons. Neurons are the functional units of the nervous system and they are specialized in the conduction of signals. Each neuron is composed of the cell body containing organelles, and two types of nerve fibers: the axon, which is a long fiber with branches at the end, and the dendrites that are short and numerous. Several axons are surrounded by a myelin sheath that is formed by Schwann cells and has an isolating function; in fact, myelinated axons conduct impulses significantly quicker than unmyelinated axons. In a neuron at rest, the electric charges on both sides of plasma membrane are unevenly distributed, so that the inside of the cell is more negative than the outside; this charge difference is -70 millivolts and it is called resting potential difference. The resting potential difference arises as a consequence of the different concentration of ions inside and outside the

cell. An adequate stimulus alters the permeability of a portion of the plasma membrane, thereby allowing the ions to pass through appropriate channels; the membrane potential is briefly reversed, creating an action potential and then it returns to the resting state. The action potential self-propagates in one direction thanks to the electrical changes that it induces in the membrane of the neuron. In order for the action potential to be triggered, stimulus has to exceed the threshold value. If the stimulus is below this threshold, no action potential is generated, otherwise an all-or-nothing response occurs; action potential transmit stimuli of different intensities to the central nervous system by varying their frequency which increases with the stimulus. The communication between a neuron and an effector organ occurs through junctions called synapses. Electrical synapses allow the transmision of signals from one cell to another, inasmuch as the ends are in direct contact; at a chemical synapse there is a gap between the two cells where one neuron releases a neurotransmitter that binds to specific receptors on the postsynaptic membrane. Depending on the neurotransmitter, the postsynaptic cell may either foster (excitatory synapse) or inhibit (inhibitory synapse) the onset of the action potential. An individual cell can receive multiple signals from different cells; whether a postsynaptic neuron produces an action potential depends on the sum of excitatory and inhibitory signals. Many nitrogen-containing serve as neurotransmitters: acetylcholine, biogenic amines such as adreanaline, noradrenaline, serotonin and dopamine, a few amino acids and peptides and nitric oxide (NO). Several psychoactive drugs act at the level of synapses by mimicking the action of neurotransmitters. Those animals that exhibit radial symmetry are endowed with a nervous system composed of a network of neurons which enables the coordination of simple tasks such as nutrition and movement. Most animals with bilateral symmetry display cephalization, namely the concentration of nervous tissue at the cephalic end of the animal, and centralization, i.e. the presence of a nervous system which is distinct from the latter. In the vertebrates, the central nervous system consists of the encephalon and the spinal cord, within which there are cavities filled with fluid, namely the cerebrospinal fluid, specifically, ventricles in the encephalon and the ependymal canal in the spinal cord. The central nervous system is protected by the meninges. The cranial and spinal nerves form the peripheral nervous system. In vertebrates, the peripheral nervous system can be subdivided into two functionally different components: the somatic nervous system, which controls voluntary activities, and the autonomic nervous system, which directs the operations of the glands and other involuntary activities such as digestion and blood circulation. The autonomic nervous system is in turn divided into the sympathetic, parasympathetic and enteric nervous systems.

175 *Muscular system*. The muscles interact with the bones to enable the body to move. Skeletal muscles are organized in pairs of antagonistic pairs, where each muscle in the pair produces a movement in the opposing direction with respect to that produced by the other. Muscles can perform work only when they contract. The muscle fibers, or cells, are composed of bundles of myofibrils, which contain sets of thick and thin filaments that partially overlap and are made of myosin and actin, respectively. The sarcomeres are repeating units of thick and thin filaments which form the contractile units. Muscle contraction is explained by the sliding filament model. The myosin heads of the thick filaments bind ATP (adenosine triphosphate), thereby charging themselves with energy. Then, the heads stick to the binding sites of actin which constitute the thin filament and they pull the thin filaments towards the center of the sarcomere, thereby causing it to contract. Finally, the motor neurons carry the action potentials that trigger the muscle contraction. One motor neuron and the muscle fibers it controls form a motor unit. The acetylcholine, which is released from the neuromuscular junction, triggers an action potential that flows through the tubules into the center of the muscle cell. At this point, the calcium released from the endoplasmic reticulum initiates the muscle contraction.

176 This may occur when a drug alters a consolidated compensaory cycle, thereby producing a short-term benefit while nevertheless increasing the likelihood of structural problems in the medium run. For instance, selective serotonin inhibitors (which are used as antidepressants) may yield temporary improvements in mood, but they also interact both with the endocrine system (and thus, the reproductive, cardiovascular, digestive, etc…) and with the nervous system itself, thereby resulting in an addiction that is difficult to break.

177 The indirect measurement is marked by the inherent possibility of being distorted by external factors. For instance, as far as the discussed case of the heart is concerned, both the recovery time after exercise and the cardiac frequency at rest may be strongly affected by emotional and mental factors. A well-known example is that of those people who "seem" to be suffering from hypertension only because their blood pressure increases as they see a docto (white-coat stress). Unfortunately, the Holter monitor (namely, a device accom-

panying a person throughout the day to detect blood pressure at regular intervals) is not a conclusive solution since, very often, the problem is not much white-coat stress (how narcissistic of doctors!) but rather, and more simply, "exam"-induced stress.

[178] Hence, to paraphrase the famous dictum of Decimus Junius Juvenal, not only *Mens sana in corpore sano*, but also *Corpus sanum in mente sana*.

[179] A few researchers maintain that all these aspects should be comprised under the term "medicine". We would certainly support this proposal if it weren't for the fact that, for far too many years, "medicine" has devoted an excessive attention to the physical component, while almost completely neglecting the psychic facet. The term psychoneurophysiology serves us a reminder that there not only exists what relates to the "physio-" part, or only what falls within the psycho-" sphere, but rather they are both there and they are connected to each other via the "neuro-". It is likely that in a few years we will be able to return to the originary term "medicine" without none of the two factors being ignored, nevertheless, for the time being, we prefer to employ the term "psychoneurophysiology".

[180] Our vision should be able to put the old-age dispute between inherited and acquired characters into an adequate perspective. The initial endowment (i.e.genetic aspect) and experience (environmental aspect) do matter, but it is equally important to be able to train and self-modify (i.e. self-referential aspect). It is virtually impossible to favour one aspect over all the others. All of the three certainly exist, as well as all of the three critically contribute to the final outcome, namely the set of "skills" of one specific person.

[181] In a perspectove of semi-immortality, the relativity of measurement is an essential criterion, both on a physical and a mental level. According to our systemic vision, the body is endowed with a strong compensatory and self-regulating component, therefore, apart from some extreme cases, what we need to take into consideration is not the absolute value, but rather how such value evolves over time.

[182]An example of measurement of the nervous system from the standpoint of the body, and thus a "passive" one with respect to the execution of a task, may

be given by the calculation of the time between a peripheral stimulus (for instance, a shock or a flash of light) and the reception of the signal within the brain (which is measured, for example, with the EEG).

19. iSPT" Postgraduate Master's degree

For many years we have been considering the project of an educational system that would allow us to transfer our researches on a large scale and, most importantly, to illustrate our interpretative key for the understanding of reality (and the related technological progresses). However, only now we feel ready to organically address this issue. This book can be seen as a track through which not only it is possible to hypothesize what the ultimate goal of existence might be, but also to provide an interpretation of the whole evolution of human history and culture. Again, we want to point out that we cannot be certain that this is indeed the right track, nevertheless, we can safely assert that it is a universal and, at the state of current knowledge, a reasonable answer. However, we stand ready to modify our path according to new discoveries.

The primary responsibility of the school of semi-immortality will be to prepare the players. At the same time, it will also be the ideal environment to refine our knowledge of both reality and the system man. In practice, after receiving a basic education, the players, in turn, will have to provide their own contribution to the evolution of science, philosophy and technology and, concurrently, they will be committed to the achievement of semi-immortality both for themselves and the people around them. In accordance to the scheme "perception => thought => action", first of all, they will have to be taught to enhance their senses, mind and actions. In particular, the enhancement of mental faculties will involve all the facets of our "software", paying a balanced attention to its various components (*in primis*, the logical, analogical and realizational modules). At a later stage, each player will focus on the preferred area of interest, while nevertheless bearing in mind that any type of solution is fostered by a thorough comprehension of the whole.

So far, there is nothing particularly new with respect to other educational settings, perhaps, except for the concept of "interpretative key". The answer to questions such as "why do I need to study the theorem X, rather than the character Y?" will be inherent to the path: the purpose is to attempt to attain the Solution to the Game, and therefore semi-immortality. Aren't you interested in the Solution to the Game? No problem, drop the theorem X and the character Y.

The interpretative key will have a twofold usefulness, namely to equip both students and teachers with a map to read any topic and to draw a line between what is worth attention and what can be considered secondary, if not irrelevant. At a certain stage of the educational stage, students will have to be instructed to absorb the following basic notions: we cannot really be sure of anything and truth is simply a tendency that must be pursued through successive approximations. Today, anyone who advocates otherwise is either acting in bad faith (and thus is willing to use us for his own ends, be these economic or political) or is not sufficiently intelligent (and therefore is vety unlikely to have something vaguely interesting to say). What we can do is to commit ourselves to present an interpretative key that is constantly updated with the latest scientific, philosophical and technological advancements. Without prejudice, without fear. The same axiomatic structure of the Game (and of the resulting semi-immortality) has to be constantly put into question: only in this way we will be open to any other interpretative keys that might prove more convincing and, at the same time, we will be able to keep track of our cognitive choices, improving and refining them every day.

The crucial point is that we "must live" (whatever this expression means) and it is reasonable to assume that living well is more desirable than living badly. The only alternative is to exit the game or to stand still (which, at the end of the day, is the same thing). In practice, standing still means being swept away by everyone and everything. It may qualify as a strategy, but it is one we do not uphold, not only since it certainly won't lead us to semi-immortality, but most of all, because we see no fun in it. The interpretative key based on the idea of an immanent God, if purified of any preposterous fideistic certainties, is perhaps better than nothing, yet it has never convinced us[183]. Just as we have never been persuaded by all the other interpretative keys we have examined over the years. The axiomatic structure of the Game, and the resulting path towards semi-immortality, is the only option considered satisfactory by all of our three minds. Hence, if it is true that intelligence is the primary positive value, then, we may justifiably believe that semi-immortality is the only really intelligent explanation and, in this phase of human history, the sole one that may lead us closer to the "true" explanation. These are the presumptions on which we will try to construct the school of semi-immortality, and it is precisely on these presumptions that we will base our commitment to educate anyone who will have an interest in walking a portion of the path with us.

This book will be the cornerstone of the curriculum of the master's degree programme in "Science, Philosophy and Technology for semi-immortality" (iSPT). Each paragraph, each note, each character lends itself to further elaborations, discussions and ongoing refinements. Compared to an educational system in which too often the best students are bored due to lack of stimuli and professors rapidly run out of their intellectual energy, the interpretative key of the Game (and of the resulting semi-immortality) is expected to create a fertile ground for development.

Both teachers and students will be exclusively motivated by intellectual interest, no duty, only pleasure. Perhaps an effortful pleasure, but still a pleasure. In the right context, teaching is useful also to those who teach, in particular in a school that strives for excellence. What is obtained in exchange for the transfer of knowledge is new ideas, fresh stimuli and support to researches. Beyond a certain point, we all are a bit teachers and a bit students. And our master will precisely be addressed to both those " students that are a bit teachers as well" and to those "teachers who are a bit students as well". Furthermore, consistently with our opinion about the reliability of set-piece tests, the iSPT master will not adopt a selection criterion based on a typical admission test, rather, the selection process will be conducted by means of regular contacts with the applicants throughout the year preceding entry. In fact, the path towards the master will begin several months before the course itself starts, for instance during the period devoted to the attainment of one's degree, with no aprioristic constraints related to age and the university of origin.

In its early stages, the school of semi-immortality will necessarily have to coexist with the educational settings of our current society. It is clear that the guidelines contained in this book may be suitable to any age, from nursery school onwards, but it is equally clear that, for the time being, it wouldn't be feasible to replace the existing educational settings inasmuch as they are strictly regulated by law. Apart from the crucial issue of the curriculum programme (which is simply too distant from any existing degree course), the spirit underlying the didactics of semi-immortality is not contrary to the spirit of the education offered by top universities. Perhaps, the only significant difference lies in our tendency towards the generalization of knowledge which contrasts with the current trend towards specialization. The semi-immortal man will have to be self-sufficient, or at least to possess an adequate level of knowledge to be able to

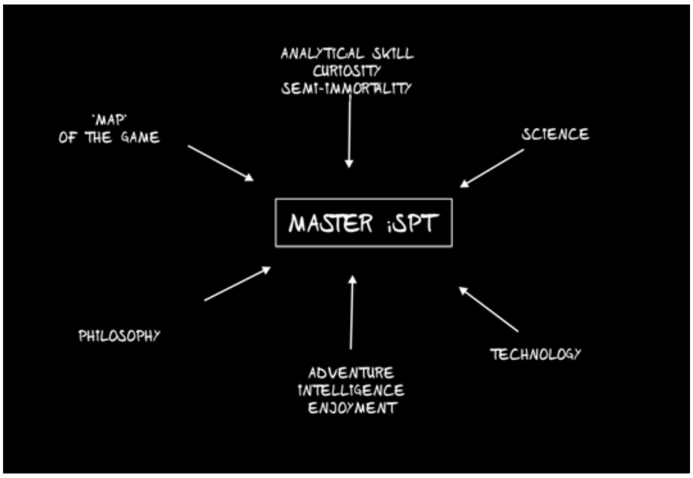

Fig. 19.1. iSPT: Master in Science, Philosophy and Technology for semi-immortality.

make any sort of important decision, perhaps consulting the opinion of more experienced or specialized people (or artificial-Selves), nevertheless, without ever delegating the responsibility for final choices to anyone else.

The iSPT master will potentially be open to anyone. Obviously, a brilliant university career, just as the passion for the subjects treated and the acceptance of the basic concepts expressed in this book, will be considered a plus in the selection process. However, the true selection criteria will rather be the love for knowledge and critical thinking skills with respect to any type of problem (these are the key traits of any "real player"). The year preceding entry will be devoted to the preparation to the course: each candidate will be provided with preparatory material, self-assessment tests and, in the final stages of the preliminary path, she will be put in contact with a tutor who will be responsible for evaluating the effective alignment of mutual expectations. There will be no time limit to prepare for entry: nothing will prevent those who are interested from undertaking this path during high school or, in case of particularly gifted students, even earlier. Similarly, there will be no upper limit of age: the well-trained, brilliant mind of an elderly person is just as able to learn and as useful to semi-immortality as those of young people. The real problem of the elderly people does not stem much from lower levels of resistance and speed of reasoning (which are often offset by an increased cognitive efficiency), but rather from their progressive distrust for anything new. The feeling of antipathy in dealing with what is new is a mental attitude that, in evolutionary terms, is both understandable and justifiable, yet, as we approach semi-immortality, it must be radically changed, otherwise we will inevitably exit the game. Continuous adaptation to novelties is a tiring, energy-consuming task. We must keep ourselves well-trained. Just as there are elderly people who are able to participate in a marathon with better timings than many (maybe young, but not trained) persons, so there are elderly people with superior cognitive abilities (orchestra leaders and chess masters are classic examples in this department). Here we encounter again the crucial problem of measurement in the field of psychoneurophysiology: how can we timely become aware of the decline of our faculties? Well, the answer lies in measuring them! This is the only way to reverse, or indefinitely slow down, the ageing process.

19.1 The curriculum programme

Unlike the curriculum programmes we are generally accustomed to, ours will feature three distinct levels of development. All things considered, the "logical" curriculum will correspond to a standard one, with several subjects and related further investigations: without engaging in an analytical discussion here, the logical curriculum programme will be composed of the topics covered in the various sections of the book (artificial

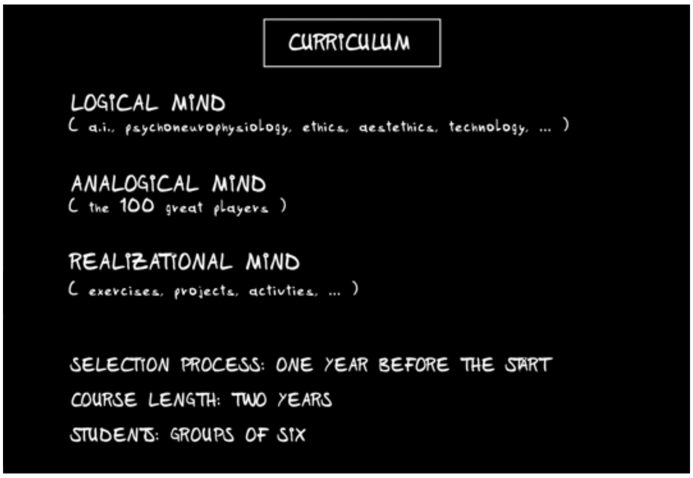

Fig. 19.2. The curriculum programme.

intelligence, psychoneurophysiology, ethics, aesthetics, technology, etc...). The "analogical" curriculum instead will be concerned with the study of the life and works of those we have defined the great players (from Pythagoras and Buddha onwards). Finally, the realizational curriculum will involve specific exercises aimed at enhancing the students' physical and mental abilities. Moreover, the realizational level will also provide the main framework of evaluation, since the ultimate goal of the school of semi-immortality is not the mere transfer of concepts (which may be, by definition, wrong or at least incomplete), but rather the preparation and the enhancement of the players' mind, and, in turn, they will be the architects of the ongoing refinement of the various concepts[184].

The master programme is of two year duration, at the beginning of the second year the student will be given the possibility to choose a specific topic that will become the object of the final dissertation and, eventually, the base for the foundation of her professional career. The economic idea underlying the master should be that of the "zero-sum game", namely there should be no loss, but we have no interest in generating profit either. This approach should allow to charge a reasonable entry fee. Our own businesses should ensure, at least in the earliest stages, the financial viability of the project in exchange for the increasingly difficult training activity. We think it won't be very difficult to involve other companies that might have an interest in this type of training.

Let us now see in more detail the curriculum programme and the selection criteria. The interpretative key of the Game, and of the relative semi-immortality, will be the compass guiding any of our efforts. The possibility for man to eventually attain semi-immortality can be essentially shared, essentially rejected, or essentially subjected to critical scrutiny. In the first and third cases, the master may represent an extremely interesting opportunity for both students and teachers. To share the semi-immortality hypothesis means to consider it as the most probable, or, at worst, the least unlikely one among all the interpretative keys that are currently available. To subject it to critical scrutiny implies to accept its possible usefulness and to grant it a "preference" only at the end of the knowledge process. By contrast, the firm rejection of the possibility for man to indefinitely extend human life span would undermine the feasibility of a structurally shared path (though not the opportunity to collaborate on individual projects or to mutually make use of specific services). All this holds from an analogical point of view. From a logical standpoint, we fundamentally rest on the absolute value of "truth" (which is to be understood in the sense of description of the real) and on the concurrent "arbitrariness of systems". If they haven't been deeply analyzed and reasoned out in terms of personal introspections, these two concepts do not lend themselves to be immediately understood, let alone to be agreed upon a priori. The preparatory period preceding the enrollment to the course should ensure a greater clarity about these two points (and thus to verify first the comprehension and then, possibly, the sharing of these concepts).

Finally, from a realizational viewpoint, regardless of whether the goal of semi-immortality is attained or not, the master should however provide a few valuable cues to live better and longer.

Continuing to speak to the three minds (so as to become familiar with the didactics of the master from these very pages!), the "logical" level of the curriculum programme involves the concurrent study of scientific, philosophical and technological subjects (continuing along the line of the didactics of the master: can you already catch some glimpses of recursive self-reference in action?). As far as the "four pillars" of semi-immortality is concerned, the master will primarily focus on artificial intelligence and psychoneurophysiology, however, also nanotechnologies (and more generally physics) and genetics (and more generally biology) will be treated in sufficient depth with respect to our goals. The philosophical part will be discussed in a linear fashion starting from the arbitrariness of systems and then proceeding to ethics, aesthetics and society. Each logical step will be investigated and subjected to critical review (those who might be interested can begin to carefully read the numerous notes to the philosophical section of the book). Finally, the technological training will involve the "active" participation in one of the six projects that will periodically be selected by our research laboratory and the "passive" participation in the other five.

The "analogical" level of the curriculum programme will provide for the articulate knowledge of all of the one hundred great players (according to the "official" list that will be in force at the time). The entire range of the topics of the logical level will be reconsidered from the perspective of the players, placed into their historical context and their psychological and cognitive profile as well. A thorough knowledge of the findings of our most remarkable (and often "bizarre") predecessors should save us from several mistakes and risks. The schedule should provide for the required study effort at a rate of at least one player per week, taking into account any desirable prior knowledge, this is a typical case in which the preparatory period before the master clearly appears as extremely useful. For instance, from the standpoint of the educational approach, the study of differential mathematics would be a real contradiction as well as a futile effort, if not based on the knowledge of the figure of Gottfried Leibniz. Differential calculus and integral calculus must be placed in the historical and scientific context of the late Seventeenth century and interpreted in the light of Leibniz's specific research path in order to gain a clear meaning, which would be far more difficult to understand if these concepts were explained in a decontextualized fashion[185].

Finally, the "realizational" level of the curriculum programme will be centered on the attempt to capture the practical essence of the various concepts, through specific exercises and practical activities. Therefore, not only we cherish the development of skills such as computation, contemporary reasoning, comprehension of contexts and identification of regularities, but also the enhancement of other abilities such as the perception of direction in the dark, balance, coordination, concentration and strength. In a nutshell: not only thought, but also action and, of course, perception intended as the ability to precisely distinguish sounds and colours, but also as the ability to identify emotions and their associated intensity levels. The preparatory path before the master will prove extremely helpful also as far as the realizational level is concerned. The attainment of semi-immortality will not only rest on strong mathematical or language skills, but also on an adequate physical preparation (for instance, endurance in running), a proper psycho-physical control (which may be achieved, for example, through precision sports like archery) and a natural propensity to enjoyment and self-care.

Classes will be composed of multiple of six, up to a maximum of thirty-six students. At the beginning of the master, every student will be evaluated in each of her basic components (i.e. logical, analogical and realizational) and in her ninety-six secondary components (according to our simplified psychoneurophysiological model). The main criterion underlying the formation of groups will be an even distribution of capabilities in such a way that the summation of the six individuals, as represented within our three-dimensional psychometric space, will tend to form a spherical shape. Also the faculty will have to be composed of teachers whose aggregation will tend to form a spherical shape. This methodology is intended to allow students to examine the distinct points of view and observe how the different methods of reasoning operate. Throughout the duration of the master, the measurement of the so-called "volume of the sphere" will be the primary yardstick both students and teachers will have to confront themselves with. In particular, not only the evolution of each student's specific value will be periodically measured, but also each student's ability to contribute to the evolution of the other five members of the group.

[183] We see the religious standpoint as the only "amusing" interpretative keys so far developed by man. If religion is purified from fanaticism, dogmatism and violence, which are however inherent to any system of power, whether religious or not), it remains one of the few sufficiently universal and consistent visions available. Religious rituals, provided we consider them in their essence, are fascinating just as the works of sacred art, churches, convents, religious orders, etc… From our point of view, the problem lies in the fact that the very idea of an immanent God does not stand up to the confrontation with the current scientific, philosophical and technological discoveries. And, as the concept of God is emptied of immanent contents, a substantial part of the ethical, aesthetic and social structure related to religions is bound to collapse. The religious interpretative key may have been useful (as long as the problem of faith could be solved) when semi-immortality wasn't within human reach. We think that today religion should be supplemented with something that encompasses and surpasses it, without necessarily being in contrast to it. In our opinion, the axiomatic structure of the Game is an equally "enjoyable" possible candidate, but with the considerable advantage of being closer to man's present knowledge.

[184] It is clear the difficulty we encounter in relating our approach to the present academic criteria, therefore, it should also be clear why we chose to initially propose our training path in the form of a master rather than a full-fledged graduate program.

[185] The merely mnemonic learning of the procedures of differential calculus, without understanding its essence (and without a deep knowledge of Gottfried Leibniz) is a classic example of how much time is wasted by today's school system. A myriad of reasons led to the present situation, nevertheless, in our opinion, the most serious drawback in terms of effficiency lies in the lack of a unified vision. In the absence of a thorough vision, it is very difficult to contextualize the events and any related scientific advances. Religious conceptions, notwithstanding their characteristics of universality, are considered "unacceptable" by many scientists (at least in their dogmatic versions) and most people experience them on a level that is inevitably different from that of pure knowledge. Our vision of the "Game", provided it is understood in its essence, not only is much more neutral than any religious point of view, bit it also encom-

passes the tools enabling us to self-criticize and self-adapt to any type of new discovery. At present, we believe there are no better alternatives.

20. i-ese

Over the coming years, artificial intelligence will come into our society through the front door of entertainment. It is our opinion that the appearance of robots, or any possible evolution that might manifest in currently unpredictable ways, into our everyday life will primarily serve the purpose of entertaining us. In fact, "boredom" is the central problem of our present society, namely a society that is heading towards the transition to semi-immortality. Such boredom is basically derived from two factors: hyperstimulation and the increasing difficulty in meeting people to have fun time with. As we know well, boredom is one of the most disturbing side effects of intelligence. The more intelligent we become, the higher the likelihood of being bored. If we were to speak in religious terms, we might define boredom as "the real divine punishment for the sin of pride committed by men who think they can gain knowledge". Perhaps, this is true, although we prefer to conceive boredom as a level to overcome, one of the numerous "traps" scattered along the path towards the Solution to the Game. Thus, we simply think that boredom is to be analyzed and resolved.

The one-love is one of the most efficient "natural" remedies against boredom. The problem is that only a limited number of men and women have the good fortune to be able to realize it. And even fewer are those who manage to preserve it for a long time. Furthermore, also the one-love is not immune from the risks of hyperstimulation and isolation, perhaps a "sugar-coated" one, but still an isolation and, from the perspective of semi-immortality, the "isolation of a couple" may not always be an adequate response.

After these brief reflections, we should now be able to grasp the essence of the problem. Many people are becoming more and more "intelligent" and the implications of this fact are twofold: on the one hand, it provides a better understanding of both the world around us and ourselves, while, on the other, it inexorably draws us away from those that may be defined as "common inclinations". And it is this departure from common preferences that determines the need to seek for new incentives, technology is able to provide most of the responses to this research, therefore, partly directly but chiefly indirectly, it leads to hyperstimulation. Hyperstimulation results in an increase in sensitivity and intelligence, thereby further expanding the distance from common inclinations... and so on. This is a "virtuous" circle as far as people's mental development is concerned, but it is also the ideal environment for the growth of boredom.

When faced with the prospect of semi-immortality, a significant number of people identify boredom as one of their main reasons of concern, and thus of disinterest in an indefinite extension of life. Well, how to blame them? Many people today lack adequate interlocutors to share their experiences with. This is why we think that as soon as the artificial-Selves are able to deal with men on an equal basis, they will be formidable catalysts for the development of the new human culture. We speak of catalysts because, as we have repeatedly pointed out in this book, we do not believe in man's loss of centrality. Rather, what we believe in is an evolution of man, perhaps a radical one that will occur through a qualitative leap whose implications are still not clear, but certainly not a replacement of man. If we look at it with today's eyes, the near future may appear as alien to us in many respects, but, with tomorrow's eyes, it will simply emerge as the obvious consequence of our present science, our present philosophy and our present technology.

20.1 A new language

We deem it probable that the society of semi-immortality, which will be inhabited by artificial-Selves and evolving men, will develop a new language to communicate and retain knowledge. This new language will be none of the currently spoken languages (without offending the supporters of the English language), but it will rather be the language enabling us to construct the first operational artificial-Selves (thereby allowing man-machine communication). At the present time, our research laboratory is still far from developing a fully functioning artificial-Self, nevertheless it was immediately clear that, if we were to progress in this path, we would need to elaborate a new language. The language we have developed, as it was natural to expect, builds on our basic idea of the models of reference. Therefore, we will have a certain number of innate models of reference that will form the basis for the construction of all the others. Both the grammar and the syntax will reflect the *perception* => *thought* => *action* setting, trying to make communication smooth with a sequential and continuous speech flow. Phonetics and writing will have to minimize possible ambiguities and be easily understandable to anyone, regardless of the language of origin[186].

Thus, the i-ese project is very closely related to the development of the mathematics of the models of reference. If the models of reference represent a valid formal framework to describe the operation of the human mind, then we can reasonably expect that a language which is directly derived from such framework will bring about considerable advantages. However, regardless of any formal aspect, the essence of i-ese rests on the identification of those primitive concepts that are present within man. In line with the theory of the genetic origin of language, one of the main, if not the main, steps is to undertake an analysis to the root of human reasonings in order to identify those we may call our "basic semantic building blocks”[187].

The possible starting points are varied. As far as the development of i-ese is concerned, we have chosen to adopt two perspectives that are, in a sense, “culturally” opposed to each other. The first approach is based on the description of reality as presented in the philosophical section of this book, a sort of “progressive” semantic inference: as soon as there emerges the need to use a new concept, this is either defined as “primitive” (and thus innate) or it is “inferred” on the basis of a certain number of previous concepts[188].

The second perspective rests on the study of human cultures, in particular the primitive cultures where the comparative analysis of various tales and legends highlights the existence of common semantic constants. When certain specific “configurations” of subjects, objects and actions are able to universally elicit emotions, then it is reasonable to expect that those “subjects”, “objects” and “actions” are directly wired within our mind[189]. Also the study of children's fairy tales and very popular novel may prove very useful in this regard. We think that the prospective candidates to the role of “primitive concepts” should be as universal and essential as possible: hence, we expect the two different perspectives we have just described to help us achieve both objectives.

As an example, let us try to retrace the essential lines of the logical-deductive path presented in the philosophical section and to identify a few possible candidates as primitive concepts of i-ese (the primitive concepts are highlighted in bold as they appear for the first time).

…first, we have the real, defined as the existent, composed of at least two, distinct yet interwined, dimensions: matter and information; by definition, there may exist other, currently unknown, dimensions, which would nonetheless be part of the existent; our physical universe, namely

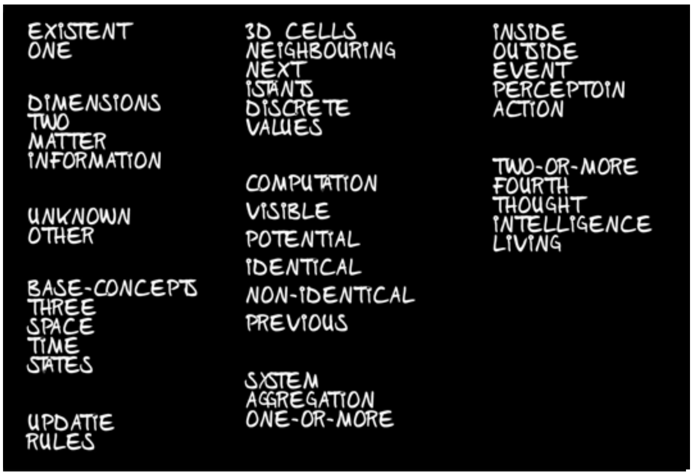

Fig. 20.1.A few possible primitive concepts of i-ese.

matter, is made of three basic concepts: space, time and states; the states of space change over time according to the rules...

…let us assume that space consists of individual three-dimensional cells that are adjacent to each other, that time is formed of single successive instants and that states are constituted of distinct, mutually exclusive, discrete values; the rules will determine the becoming of our universe by computing the value of each cell in the next actual instant; such computation is performed in the potential time comprised between two actual instants; in the next instant a single cell could be identical (i.e. having the same state) or non-identical (i.e. having a modified state) with respect to the previous instant…

…at this point, we are ready to introduce the concept of system, defined as any aggregate of one-or-more contiguous cells; if we arbitrarily identify one system as the first one, there implicitly emerge the concepts of internal and external and, therefore, three possible phenomena: event, perception and action; if the system is composed of two-or-more cells, then the fourth phenomenon may emerge: i.e. thought; at this point, we are ready to bring

about the concepts of intelligent system and of living system…

Etc…[190]

21. Unnamed Project

It's a late summer evening, five days' sail brought us from the mists of Camargue to this clear full moon night. Before us, the gulf of Genoa is stretching out, if the breeze continues as it is now, we'll be in port in about three hours.

Every now and then, the eye falls on the compass, two hundred miles ago the battery charger blew up, ever since then, we've been proceeding relying solely on the force of the wind and without the aid of instruments. Just like the "true" sailors of past centuries.

To our right, the moon is lighting up the waves of the sea. Close to the hull, the dynamic performances of the flying fish are clearly observable. A cool breeze of north-east wind brings our attention back to the route, soon we will encounter the buoys of the fishermen.

Night visibility is perfect thanks to the moon alone.

In the distance, a large cruise ship is entering port. We can glimpse the cabins lit up and, being us downwind, there are weak hints of voices and music coming.

Between the two extremes of the coast, the life of tens of thousands people are flowing on inside their houses lit up and scattered around the top of the hills. Those same rooms have witnessed the passage of various generations of men and women from every corner of the Earth, with their stories, their joys, their tragedies, their boring everyday life.

A large cargo ship is at anchor, standing still in front of the industrial *zone of the port area.*

Often, the sea takes its toll in terms of effort and respect, but it also gives moments of magic, this is one of those moments.

Our mind retraces the history of these places, many other ships have preceded us on this very same route... caravels, galleons, merchant ships, goods from all around the world, crews.

Can you see the coast in the distance, all illuminated by the lights? The breeze is delightful. The hands lay on the rudder. The gaze is alert, focused on the route, but relaxed. The sea is calm and the wind is just perfect.

The moon is high in the sky and illuminates the sea, every now and then we hear the sound of a fish jumping on the sea surface.

It's just beautiful.

We try to concentrate all the persons who live in those houses before us into one thought. Thousands of lighted windows. Thousands of families. The flow of their lives, individual and contemporary. Now, we move our gaze towards the hills.

We take a deep breath and feel the smell of the sea at night. There is a buoy about a hundred meters away, we imperceptibly draw up to the left.

We feel relaxed and full of energy at the same time.

That cruise ship entering the port is a large one indeed, how many people will it be carrying? All the decks are lit up, many people must be leaning out the balustrade. There is a striking difference from the cargo ship at anchor on its left. The dimensions are similar and it must be carrying no more than a dozen crew members. Only the anchor lights are illuminated. Who knows where the crew comes from? Right, the crew... their families.

At this point, we are also captured by the dynamics of the waves. We *think about all the forces that led to the formation of these waves that are gently drifting our boat... a gust of wind hundreds of miles away, the configuration of the seabed, the other boats encountered along the way.*

Wow! Who knows what this big mess might mean?

Welcome to the world of the unnamed project and to the domain of ecstasy (and perhaps also that of meta-self-reference).

There are times and situations in everyone's life when one passes into an area that is difficult to define. Certainly, such area is characterized by sensations and perceptions that instill into our minds the suspicion that "out there" something more than a mere random cluster of atoms may exist. When these perceptions are particularly intense, clear and aware some speak of "ecstasy", others of "merger with the whole", and others still of "enlightenment" or of "mystical experience". We prefer not to use any specific term and to let everyone relate it to the domain that is most suitable to each person, perhaps following a semantic path whose outcomes are not entirely predictable. The neuroscientist will start from the endogenous production of the endorphins and opiates that are responsible for the sensation[191], the artist from her own direct sensitivity[192], the man of religion from the spiritual path[193], the philosopher and the mathematician from the observation of the underlying laws[194], etc… From here the Unnamedness of the project.

Those who have been lucky enough to encounter this type of sensations should know what we are talking about, those who have never experienced them, in a perspective of semi-immortality, should pursue them with commitment and discipline. The "Unnamed project" is dedicated to all those who have undergone that kind of sensations and recognize such experience as a useful instrument of knowledge. And also to all those who have never experienced them and would like to.

21.1 Approaching

As we have previously stated throughout the book, we are not "believers", even though, deep down, a part of our mind feels a bit of envy for anyone who genuinely believes in something. But we just cannot do the trick, the arbitrariness of systems is, as they say, both a blessing and a curse. In the essence, we do not even believe in the Game, we simply see it as the only reasonable option available to us: not only is it a very useful approach, it also is not in stark contrast to the current scientific, philosophical and technological knowledge. In the most rigorous terms, we consider the Game, and semi-immortality, as the option that gives the highest utility level for each individual and, at the same time, as the approach that is most consistent with the whole range of known physical and mental laws.

On the basis of this fundamental premise, we can now begin to explore the domains of the Unnamed project. There exist both "external" and "internal" places that seem to universally favour the emergence of such sensations. Among the external sites that qualify as good candidates, we may mention the deserts, mountains, and oceans. These are all places where the contact with the ultimate laws is encouraged. Among the internal sites that qualify as good candidates, we may include meditation, prayer in sacred places and the phase of morning awakening. There also exist "paths" that seem to universally favour the emergence of such sensations: for example, a prolonged fast, a long solo voyage or the continuous contemplation of a symbol.

This book, just like everything we have managed to attain (and preserve!), would not have been possible without the regular access to that kind of experiences. It is precisely through those experiences that one may hope to glimpse the Laws and the non-Laws. And it is through those experiences that one may somehow anticipate the future, heal both the body and mind and discern what is right from what is wrong. But, most importantly, it is through those experiences that one may attempt to access to yet unnamed "things".

A whale coming close to your boat to greet you during a storm off the coast of Tonga islands, A solitary chromatic night spent in the moonlight in the desert of Sinai after your jeep got stuck in the sand, but also an awakening in which you realize you have had the privilege of catching glimpses of a few lines of the Software or a deep meditation with your one-love: what domain does the perfection of these situations fall into? How do you call the "issuer" and who is the "receiver"?What is the nature of this kind of "sound"?

We believe that any sort of significant scientific, philosophical and technological progress draws its "energy" from this domain. As we read and reread the direct testimony of the great players, we recognize this energy and, in a few cases, we may even be lucky enough to experience some form of "resonance". Perhaps, hundreds or thousands of years apart. It is a way to identify each other among us players, however great or small we might be. A sort of *backdoor*[195] efficiently wired into our DNA and thus into our mind.

The unnamed project aims at approaching this type of energy, learning to recognize it and to use it for the purpose of semi-immortality.

[186] Syllables that are composed of one consonant and one vowel whose phonetics is unambiguous may be good candidates for the role of "basic alphabet" of i-ese: for instance, the consonants d, f, g, k, l, m, p, r, s, t, v, z combined with the five vowels generate uniquely identifiable and distinguishable sounds, regardless of the listener's language of origin.

[187] One of the more interesting recent findings in the area of cognitive science is the fact that the syntactic structures underlying language are somehow "cabled" within our hardware. This implies (at least) two things: first, that differences among languages actually are just "accidents" that do not affect the deepest structure of grammar As Noam Chomsky often points out with a joke, should a Martian linguist visit Earth, he would deduce that all men speak only one language with a number of local dialects. The second immediate implication is that the infinite complexity of language must be reducible to a finite set of primitive structures and instructions both to modify them and to recursively create new ones. This remark is intended to clarify the project underlying i-ese: as we have already accurately explained, the basic idea is that not only the structures but also the concepts are "cabled" within the brain of human beings. If this is true for syntax, then closely analogous considerations must apply to semantics as well: on the one hand, we expect the stock of innate concepts to be roughly the same for every human being (with some "accidental" difference perhaps related to the culture of origin), while on the other hand, we think that the infinite complexity of our concepts can be reduced to few primitive meanings and to few operations through which new meanings may be constructed starting from those that are already available.

[188] Just as in the mathematics of the models of reference.

[189] Again, also in this second case, just in line with the theory of the operation of the mind as derived from the models of reference.

[190] And so on … carrying on with the whole philosophical construction related to ethics, aesthetics and society, including the *Prelude*.

[191] Endorphins and opioids are substances that are produced by both our brain and, autonomously, by other glands (i.e. endogenous production) under particu-

lar conditions. Endorphins are able to make us feel pleasure, satisfaction and happiness, thereby helping us to better cope with stress and fatigue and stimulating good mood. A fairly common example of this phenomenon is the sensation of pleasure that is experienced after an intense physical activity.

[192] *Stendhal Syndrome.* The Stendhal syndrome is a disease that tends to affect extremely sensitive individuals when they are exposed to particularly beautiful art, causing apparently inexplicable emotional and physical reactions (dizziness, tachycardia, crying, fainting, etc…). It is named after the French writer Marie-Henri Beyle (aka Stendhal) as he was the first to describe this phenomenon relying on his own direct experience. The individuals who experience this particular condition exhibit different reactions, yet there seems to be a common "path" underlying it (namely, it appears to be regulated by general and primitive laws). This is why several branches of science and analytical philoophy have dealt with this issue in the attempt to explain it. Some of the fathers of psychoanalysis, including Sigmund Freud and Wilfred Ruprecht Bion, argued that such condition stems from an insufficient elaboration of mental experiences that reemerge as the work of art provides them with a space where the process of symbolic synthesis by the unconscious can resume its course. In his "Critique of Judgement", Immanuel Kant addressed the issue from a philosophical point of view by identifying the concept of sublime. Kant maintained that the Self, as confronted with the contemplation of nature or some powerful and "large" artifacts, becomes aware of its rational boundaries and, at a purely emotional level, it experiences the very possibility of a "transcendent" dimension. It is a pleasure produced by the contrast between an earlier sense of suspension immediately followed by an outpouring of emotions: the Self is simultaneously attracted and repelled by the object (feelings of wonder and esteem violently clash with the sense of inadequacy resulting from the limitations of our imagination). From the perspective of our Game, the Stendhal syndrome may be triggered depending on the models of reference that click in the mind of the individual and the magnitude of associated emotions (the more intense the associated emotion, the more significant the phenomenon). In a sense, it may be seen as a consonance between the mind of the artist and the mind of the observer: an "automatic recognition" among the models of reference of the various players.

[193] *Mystics.* <the individuals who are endowed with remarkable sensitivity and

"introspective capacity" appear to be particularly inclined to the knowledge of their own selves. Most probably, the inner drive is to be found in the attempt to achieve the unspeakable, the indeterminate, the absolute (in philosophical terms). Clinging on the need to attain such goal, these individuals are able to reach an excellent level of awareness. The inner path of each of them is fairly similar as far as the basic guidelines are concerned: solitude (it is interesting to note that all these persons spend a long period of heremitage at the beginning), abstinence from material passions (i.e. chastity, fasting, indifference to money), meditation and reflection seem to be essential and common requirements. Only through a progressive detachment from the self and the world it is possible to unite with the Whole. However, such detachment is, in a sense, an "intelligent" one: this process can occur only if one achieves a thorough knowledge of the darker sides of one's own Self (obsessions and paranoia) which spring from the fear of failing in one's mission as a player. In the specific case of the mystics, the ultimate "goal of the game" will be, on the one hand, to convert all men to God, on the other (at a personal level), to lose themselves in his greatness. Just like for any other player, paranoia will inevitably be related to failure: visions are not "outside" the individual, rather they are inner manifestations of one's own will and paranoias (what is worse for a believer than giving in to the Devil?). Among the most interesting figures in this respect, three should be singled out. These three lived in the same historical period and in the same geographical area (i.e. Egypt): Saint Anthony the Abbot (251), Saint Pachomius the Abbot (292) and Saint Macarius the Egyptian (300). At the early age of twenty, Anthony sold all of his possessions to devote himself to the ascetic life. He started the movement called "monasticism" encompassing the individuals who want to engage in a deeper spirituality, in complete solitude in order to live in contemplation of divine mysteries and to fully belong to God. The first part of his path was devoted to work (to provide for his own livelihood, giving all the rest to the poor) and prayer. A few years later, paranoid thoughts started to trickle in: doubts about the choice of a solitary life, attachment to material goods, sexual instinct. This led him to follow in the footstepf of Jesus of Nazareth who had retired to the desert "to be tempted by the devil", as the common belief was that purification could be attained only through solitude, so Anthony took refuge in an ancient tomb excavated in the rock of a hill. After years of complete hermitage, many people began to follow his example leading Anthony to think that his own inner journey had been fulfilled. Thus, he decided to devote his life to help others: this led to the formation of groups of monks who later founded two monasteries resting on his precepts; then he went to Alexandria to support the Chrstians who were being harshly persecuted. After growing tired of excessive contacts with human beings, he decided to retire to the desert of Thebaid, where he began to grow a vegetable garden for his livelihood and that of his disciples. Pachomius instead had a differentlife path and his eremitic experience (his encounter with God in the desert) led him to pursue another side of the teachings of Jesus: hence, he gave rise to a particular form of monasticism called "cenobitism" or common life. A particularly interesting factor was the utmost importance of discipline and authority (prior to his conversion, Pachomius had been in the army) as well as the communion in prayer, work and mutual service. Finally, Macarius who was a disciple of Anthony. He was a camel driver and probably a robber before being overwhelmed by the strength of his master that induced him to devote his life to God. Subsequently, since he was considered dangerous by the Arian bishop of the time, he was exiled to an island in the Nile. His monastery, namely the monastery of Abu Macarius (the white of its architecture immersed in the ochre of a desert is still famous) had a remarkable intellectual influence in the history of Egyptian monasticism.

[194] At the beginning of Greek thought (and therefore of Western thought) *logos* and *mythos*, logic and analogy, science and religion, were inextricably interwoven. In fact, under the influence of Oriental doctrines, the early Greek philosophers, who engaged in the attempt to reduce the diversity of Nature (i.e.*physis*) to few laws and originative principles, combined reflections of an abstract and quantative nature with analyses at existential and practical levels. This commixture is most significantly exemplified by the figure of Pythagoras, who, on the one hand, can be regarded as the founder of mathematics taking the number as the fundamental element underlying the structure of the cosmos, while, on the other, he divulged a number of mystical doctrines such as metempsychosis (i.e. the transmigration of souls after death) and *hesukia*. This term is semantically related to silence, sleep and dreams and it had already been used by Orphic wisdom to denote the state of sweet stillness where the mind is enabled to gain access to the world of gods and the revelation of the ultimate structure of reality. Strabo used this term to describe the act of standing still waiting for divine enlightenment, and it seems that in the evenings Pythagoras used to play particular melodies aimed at taking his disciples to the sleep of ecstasy, namely the state of *hesukia*. In *hesukia*, the disciple could attain ecstasy and pierce "the veil of Maya". We find a telling exemplification of the complex path within the

physis and of man himself in the figure of the labyrinth, namely the manifold and chaotic network of roads where the real seems to break into fragments. The Greek term g*riphos* does not only mean "fishing net", but also "enigma": *griphos* denotes a riddle that tests the ability of the wise to overcome the thought patterns underlying everyday life to embrace a new way of reasoning in harmony with the gods and beyond any space-time confinements. This is where the study of mathematics is most crucial and it complements the functions of the existential practices: the thorough understanding of the maze and the transition from chaos to cosmos require a clear insight of its underlying secret structure which, according to Pythagoras, was based on the *tetraktys*, namely the pyramid constructed with the numbers from one to ten. The significance of a certain kind of experience of "union with the whole" and "universal understanding" is a crucial, yet often neglected, part of Western knowledge (obviously, to a different and lesser degree than observed in the Eastern experience). The *hesukia* of Parmenides (which he had learned from a Pythagorean disciple)and the ecstasy of Plotinus, are expressions of the recurring idea of the existence of moments, i.e. special states, in which the inessential vanishes thereby allowing us to see the "real" world.

[195] A *backdoor* is mainly known as a method to gain access to a computer system while bypassing the normal authentication processes, usually with the intent to operate without the user's knowledge. Such doors may be opened in a variety of different ways, "cracking" the system that manages the accounts on a machine, or altering the functionality of existing programs, or inducing the target user to install a specific software on his computer. However, the true origins of *backdoors* are to be found in the vast, fascinating world of the so-called "undocumented features", i.e. those hidden components that are placed by the programmer. That are several reasons (not all of them mischievous) which may lead a programmer to place a *backdoor* into a program of his. For instance, to enable the user to access the software in case of emergency, whether for the sake of fun or due to an unintentional error. A typical example of how undocumented features can be activated is a certain "improbable" sequence of keyboard or mouse actions that allows the user to fully access certain features of the program, or more "peacefully", to a series of greetings for posterity or of funny jokes for fans of the genre.

FINALE

22. The 100 Great Players

As stressed in several points throughout the text, we believe that most likely the ultimate goal of human life rests in the comprehension of the rules governing the universe we live in and that by reaching a full understanding of such rules we will approach something very close to immortality. We don't know whether it will be us to fulfil the task: in the worst scenario, we will have lived in pursuance of the wise suggestion by Mohandas Gandhi: learn as if you were to live forever, live as if you were to die tomorrow.

All over the book we have mentioned, obviously not randomly, the 100 players we deem to have had the most impact on our backgrounds. The greatest attention has been paid to the sentence you have just read: we don't claim to draw up a definitive list, let alone an absolute one. We have simply thought that it might be interesting to single out the 100 people who, to say it in our language, provided us with the models of reference we value most. If you enjoyed the book, you will probably consider this chapter as a good starting point to elaborate on the various subjects treated herein. We think that the concepts, if separated from the people who thought them, lose a substantial part of their meaning. First there is the person, how she or he lived and what was done by her or him, then there is the history of such person's thought. This is how the "new players" should be prepared in schools. Hence, if it is true that we are all taking part to the Game, then the experience of the most proficient players cannot but be our main reference.

The Library is the most intimate place in our house, the only people we let into it are those we care the most about. It is composed of a considerable number of books, all are read, many several times over. When entering, on the empty wall, there is a large fireplace and two comfortable armchairs face it, the left one is Gabriele's armchair and the right one, it goes without saying, is Antonella's. The Library is divided into sections and the first shelves of each are dedicated to the experiences of those we view as the great players. Here they are (in order of "appearance").

Pythagoras (575 B.C.)

He is the first among the Greek thinkers to found a real school, of which he is unquestionably the master as well as the repository of a huge and mysterious knowledge of divine origin: he could never be contradicted (*ipse dixit*). The core of his research has been, almost obsessively, the quest for immortality. To him we owe the invention (or at least the first western version) of the doctrine of metempychosis, which probably had been long practised in the far east: the soul is imprisoned in a body and, at each death, it transmigrates into another prison until it attains liberation from the constraints of matter. This detachment from anything that is not concerned with the soul perhaps led Pythagoras to consider the number, rather than the natural elements as for his predecessors, as the beginning and the end of everything. He was the first to realize that all there is in reality is made of numbers and relations among them, and in the numbers it is fulfilled. That is why we can justifiably consider Pythagoras, among other things, as the initiator of mathematics as a science.

Buddha (560 B.C.)

He is known all over the world under a long series of names, Siddhartha Gautama, Gautama Buddha, Sugata and many others, and is undoubtedly one of the most remarkable players in our list. Born into a noble family, he spent his early years within an imperial palace, sheltered from any negative sight of pain and death. According to the accounts of his life, at the age of 29, after the encounter with a dead, an aged man and an ascetic, he decided to leave his palace to undertake the search for enlightenment. It is to this period that his most important researches on man belong, peaking six years later with the attainment of the great "enlighetnment". Buddha views meditation as a cardinal tool for self-exploration, control of passions and pain cessation. The central element within meditation is concentration: "He who formerly was heedless and who afterwards has become careful, like the moon free from clouds, brightens up the whole world". The mind can communicate to the body provided that it is adequately instructed and trained to do so. The ability to control one's thoughts and emotions is fundamental: "Little thoughts, subtle thoughts, when followed stir up the heart. Not comprehending the thoughts of the heart, one runs here and there, the mind out of control. But comprehending the thoughts of the heart, one who is ardent, mindful, restrains them. When followed, they stir up the heart, one who is awakened lets them go without trace." The path of this great player stands out as one of a kind. Thanks to his piercing investigation of the bonds between mind and body he may be acknowledged as the true founder of psychoneuroimmunology. Buddha's death, as his entire history, is enshrouded by legend. It is said that at the age of 80 he announced to his disciples he would abandon his earthly body and then retired in solitude.

Confucius (551 B.C.)

Confucius was a Chinese sage and philosopher. He spent a long period working as a public official until he resigned all offices to devote himself to study and teaching, focusing his research on identifying the right way to live every day and on man's duties towards politics and religion. The time and social context he was immersed in were marked by the wide spread of slavery, and the value of a servant was inferior to that of a horse, yet Confucian ethics is grounded on a totally anthropocentric orientation. His teachings are characterized by the lack of explicit rules of conduct: what is right is to be determined through the interaction with the other men, in a sort of constant *feedback* centred on the thorough comprehension of others. Then, it is not surprising that Confucius' thought is incorporated in a series of aphorismatic and strongly paradigmatic concrete episodes, exemplifying this continuous exchange. Although during his life he had never committed himself to religious matters, two centuries after his death the imperial dynasty promoted his teachings as state religion, thereby originating Confucianism.

Sun Tzu (535 B.C.)

We have very few information on the life of Sun Tsu (Master Sun). He was certainly a general commanding the imperial armies of China. Most of the information that reached us is related to his work "The Art of War". It is a treatise on military tactics formulating how a battle or a war need to be evaluated, organized and managed. At the heart of Sun Tsu's system there is strategy: the basic premise is that the starting point of any endeavour must be the knowledge of ourselves and of the enemy. Strength alone is not sufficient: "those skilled in war subdue the enemy's army without battle. They capture the enemy's cities without assaulting them and overthrow his state without protracted operations". Sun Tzu's work is far more than a simple manual on warfare; rather, it defines itself as a philosophy of life, placing strife at the core of existence. In fact "The Art of War, nearly 2500 years after its writing, can be considered a mainstay, in particular in our society, where competition and adversarial relations are emphasized under many respects.

Zeno of Elea (495 B.C.)

The stature of Zeno of Elea was known in all antiquity; he was paid the admiration of Aristotle (who considered him the founder of the dialectic) and Plato who in his "Parmenides" makes the character say: "My answer is addressed to the partisans of the many, whose attack I return with interest by retorting upon them that their hypothesis of the being of many, if carried out, appears to be still more ridiculous than the hypothesis of the being of one". Throughout the centuries the West has shown a great interest in his arguments: he can be plausibly called the inventor of the *reductio ad absurdum* method. In fact, Zeno's paradoxes are remarkably ingenious and, still there is no unanimous agreement over their solution. Let us examine as an example the argument of the arrow: consider an arrow in uniform motion from x to y and consider an instant of its motion t; at t the arrow is not moving (if it moved, such motion would take time, and hence more than an instant). But the interval from x to y is made of instants identical to t: therefore, if the arrow is motionless in t, then the arrow never moves over its whole journey! From Aristotle to Bertrand Russell, from Alfred Whitehead to Graham Priest, Zeno's paradoxes have never ceased to challenge our logical comprehension of phenomena such as the one and the many, the finite and the infinite, motion and change. Quite an accomplishment for one who claimed to be a simple defender of Parmenides.

Protagoras (481 B.C.)

There is little or vague information on the life of Protagoras. What is known with certainty is that he was born in Thrace and that he was a sophist, namely a wandering "professional of culture" who offers his knowledge for sale, teaching citizens how to successfully participate in the public life of the city. We also know his political career: the political authorities of Athens commissioned him to write the democratic legislation of a new colony. Over the years, the sophist coupled his oral teaching activity with numerous written works, including some very renowned ones. In the revolutionary text "Antilogies" ("Contradictory arguments"), we are offered one of the crucial ideas of his doctrine: it is possible to formulate over one same issue two opposite predicates that are equally sound and rationally justified. Protagoras' focus is not on who is in the right, rather, his teaching is aimed at instructing how to recognize and understand the views of the other and to better defend one's own arguments. In the text "Truth" the emphasis is on the absolute arbitrariness of truth, condemning those who claim to impose theirs as absolute truth. Stating that "man is the measure of all things", Protagoras argues for the absolute relativity of truth, given the lack of an absolute and objective standard against which different opinions might be judged. Reality can be known only through one's own perceptions of the world: for any recipient system all things are only what they appear to the system itself. Perhaps Protagoras is right when he asserts that "concerning the gods, whether they exist or not, I do not know, because of the difficulty of the topic and the shortness of human life", perhaps he is not. Maybe he is both, if believing so is of any use to us!

Hippocrates (460 B.C.)

Hippocrates of Kos is considered one of the fathers of Western medicine. It is thank to his work that the medical art acquired a real technique. He capitalized on the many contributions of the Egyptian and Babylonian medical tradition, removing their theistic and mystic character in favour of a a medicine free from any reference to the divine. He interpreted illness as an imbalance: therefore the task of the physician is to "restore the balance". He focused on identifying the essential characteristics of medical practice and epitomized them in the famous "Hippocratic Oath". It might be worth noting that in contrast to the modern version, the Oath in its original form expressly forbids a physician to practice abortion: "I will neither give a deadly drug to anybody who asked for it, nor will I make a suggestion to this effect. Similarly I will not give to a woman an abortive remedy". The collection of documents contained in the *Corpus Hippocraticum* (which cannot be attributed to Hippocrates alone) has been for centuries the main reference for medical knowledge.

Plato (427 B.C.)

He lived in the period marked by the transition from oral tradition to written texts. In a sense this helped him to be considered the first great writer and divulgator in history. The education of the "players" has always been a prominent element in his view of the world. In order to grasp how important this aspect is, it is sufficient to remember that his school continued to exist for eight centuries after his death (although it did not completely stick with the original idea). The cultural education offered in the Platonic Academy encompassed the broadest fields of study and it was directed at selecting those who should progress in their studies as to govern correctly. All the students are treated as equal: the selection is entirely based on merit. In his vast philosophical work, Plato covered every theme, even though, over time, the solutions to most logical-philosophical problems he dealt with have been regarded as largely flawed. A pillar of Plato's thought is the ontological attempt to discern the apparent contradictions of our world, with the ultimate goal being to pursue and stay in the Truth that is non-contradictory. First of all, Plato resolved the problems related to the one-many dualism in order to provide the foundation to all the rest. The key idea is that the multiplicity of physical reality cannot be investigated without assuming the existence of an immutable and eternal unity to which the multiplicity constantly refers to. From here the concepts of Platonic universals and the world of Ideas (Hyperuranium), knowable only by the intellect as it is composed of pure essences, namely the eternal models of which the multiplicities are copies. Another central theme discussed by Plato is the immortality of the soul: man's earthly life is only an attempt to return to that age of gold where men and gods shared the Hyperuranium. The royal roads to this liberation from the sensitive world are philosophy and beauty, the most proper "means of transportation" to reach the Good. The soul not only has eschatological value: in his inquiry on knowledge, Plato faced a classic epistemological problem that is "how do we know so much given the chaos we are immersed in? The Platonic solution (which is exactly parallel to the Chomskian one concerning the grammatical knowledge of a language) maintains that knowledge is, in a sense, reminiscence, a recollection of something we know since our birth. Such eternal *quid* is exactly the soul. The "Timaeus" is one of the most renowned dialogues; herein Plato tries to deal with the duality between the physical world and the world of ideas. The underlying concept is the following: the eternal being of ideas s not subject to becoming, and that is why becoming (i.e. the sensible) is never true being. Hence, all that is bound by change structurally need a cause: such cause is the Demiurge, creative intelligence, divine craftsman, efficient cause of the physical world. The Demiurge shapes the matter (the space), taking inspiration from the metaphysical models (the ideas) above it. Then, cosmos becomes a copy of the pure being and time a mobile image of eternity. In the dialogue, Plato also introduced the concept of the "soul of the world": the sensible world, inasmuch as it framed by a god, must be similar to the intelligible one and therefore it must be permeated by its soul. The Leibnizian statement that "we live in the best of all possible worlds" finds a perfect exemplification in Plato: the creation of the benevolent Demiurge is oriented at making our world as close as possible to the intelligible one.

Aristotle (384 B.C.)

Concerning its influence on posterity, Aristotle's systematization of knowledge stands unequalled in the history of human culture. Besides, his life testifies to his capabilities also in the domain of realization: he was born in Stageira, but his philosophical education was undertaken in the best school of the antiquity, Plato's Academy. His talent brought him to Macedon, a rapidly ascending power, where, in 343, he was appointed by the sovereign as the tutor of his son. Aristotle continued working in Macedon until the death of the king: in 335 he returned to Athens, where he founded one of the most important schools of the time, the Lyceum. In 323, upon the pressure of the anti-macedonian faction, he was forced to retire in the island of Chalcis, where he died one year later. The logical mind and the analogical one enabled Aristotle to compose works ranging from biological inquiries to treatises of logic, from ethics to rhetoric, from politics to metaphysics. He proposed a clear and engaging partition of knowledge: first there is pure knowledge, that of theoretical sciences, metaphysics, mathematics and physics. Then we have the practical sciences, namely ethics and politics, those researching knowledge in view of action; the first basically regards the life of the single individual, the second is concerned with the political community (it must be borne in mind that, according to Aristotle, man is essentially a "political animal"). Finally, there are the poietical sciences, that is those disciplines for which the end goal of knowledge is the production of something; among them art stands out as its product is beauty and, in the famous definition of "Poetics", "catharsis", namely purification from emotions: in overturning the Platonic judgement according to which aesthetic pleasure undermines the balance of the soul, Aristotle reassigned it the capability of easing the soul and discharging it from negative emotions. In our terms, we can recognize the distinction between the more properly logical elements of knowledge, encompassed in the theoretical sciences, and those more properly analogical, contained in the reflections on action, society, and obviously art and beauty. Naturally, Aristotle's contribution is not limited to the description of the fields of investigation: Aristotle was the first to delve into every facet of knowledge. Within the domain of theoretical sciences, the invention and the study of the concepts of inference and deduction laid the foundations for a discipline, i.e. logic, whose results are today of paramount importance for philosophy, mathematics and, notably, *computer science*. On the other hand, , under an attentive analysis, it seems hard to ascribe the delay in the development of modern quantitative science to Aristotelian physics: the hindrance is not in Aristotle, who conceived his physics as a substantially metaphysical speculation, but rather in the inadequacy of his epigones. His treatises on ethics and politics represent a thought-provoking interpretation of the life of man under many of his personal and social aspects (happiness, friendship, satisfaction, public administration, etc…). Finally, his analysis of tragedy in terms of purification grasps one of the main psychological traits of the work of art in an analogical and intuitive fashion.

Epicurus (341 B.C.)

Epicurus' philosophy represent one of the most remarkable and meaningful moments in the Hellenistic epoch. His thought embodies the change undergone by the Greek man, supervening with the collapse and the disaggregation of the great Alexandrian empire: the citizen as politician, actively participating to the political life, is overthrown by man as an individual focused on his private sphere. At the age of 34, after long studies, Epicurus bought an estate near Athens and founded a private school. There he taught his disciples to conceive philosophy as a tetrapharmakos, namely as a remedy to neutralize the four main sources of worry for the soul (the fear of the gods and of death, demonstrating that pleasure can be easily attained and that pain is distant). Since its early development, Epicurean philosophy had been focused on two fundamental areas: Physics and Ethics. Epicurus formulated what can be regarded as the first materialist theory: the world is composed in its entirety of indivisible atoms that are only subject to the laws of physics; even the soul is nothing but an aggregation of atoms (although qualitatively different from those of the matter). As far as ethics is concerned, Epicurus delineated an hedonistic model, that is centered on pleasure, however, this pleasure is not the unconstrained satisfaction of every desire, but rather, the freedom from disturbance, distress and pain. From here it follows the detailed analysis of pleasures which was proficiently conducted by the Greek philosopher. It may sound as an irony (but it is inevitable until we reach semi-immortality) that a man so interested in pleasures and the removal of suffering is said to have spent the last day of his life writing these words to a friend: "I have written this letter to you on a happy day to me which is also the last of my life. For I have been attacked by a painful inability to urinate, and also dysentery, so violent that nothing can be added to the violence of my sufferings".

Jesus of Nazareth (4 B.C.)

As it is the case for many other great players of antiquity, Jesus of Nazareth did not leave any written record by himself and we have to rely on what other people wrote about him to figure out his ideas and his life. We deem reasonable to believe that up to his thirtieth year he had undergone in-depth studies not only of the Hebrew culture but also of the Egyptian and Greek ones and that he travelled and met many of the most prominent scholars of the time. Jesus of Nazareth not only was probably the greatest realizational mind of all times but, according to what we can infer from the colossal ancient bibliography on him, also an excellent logical mind and an extraordinary analogical mind. Such concepts as "he who is without sin cast the first stone", "do to others what you would have them do to you" and "father, forgive them, for they don't know what they are doing" possess a communicative efficacy that is very hard to approach. It is of little relevance that probably Jesus acquired most of these concepts during his "preparatory" studies, the undeniable reality is that he was able to move hundreds of million of people and that, from the standpoint of the ethics of semi-immortality, his guide principles are for the most part still valid. Regarding him as God (whatever this might mean) and considering him able to perform miracles (in the sense of altering physical laws) represent two passages we fail to accept (besides viewing them as alarmingly wrong in a perspective of semi-immortality). Nevertheless, it is very difficult to dismiss from our mind the doubt that these two passages cannot be attributed directly to him but rather to some less rigorous disciples of his.

Mohammed al-Khwarizmi (780)

Muhammad ibn Musa al-Khwarizmi was a Persian mathematician, astronomer and geographer and he is credited to be the father of algebra. He applied himself to the study of Greek, Indian and Babylonian notions, which led him to write "The Compendious Book on Calculation by Completion and Balancing", composed around the year 830 and regarded as the first text of algebra in history. Although the paternity of some of the ideas therein is controversial among the scholars, this text stands as a momentous landmark in the history of mathematics: the book shows how to reduce all linear and quadratic equations to one of six types and the procedures to solve these basic forms. "Completion" and "balancing" are the two fundamental operations for the reduction of equations: *al-jabr* is the name of one of the two methods; which led to the latin translation "Liber algebrae et almucabala", from which the term "algebra" was derived. The second cardinal work by al-Khwarizmi survived only in its latin translation: "Algoritmi de numero Indorum"; as it easy to see, the modern term "algorithm" stems from the latinization of his name, "algoritmi". This book on the Hindu numerals brought about an historical turning point for European mathematics: in fact, with this text al-Khwarizmi, resting on the eastern studies and knowledge, introduced the positional system and the number zero. His interest in geography led him to compose a book containing more than 2000 coordinates of cities, rivers and other geographical elements. This text is based on studies of the main works of the time and it represented both an improvement and an expansion of such knowledge (many of the coordinates assigned to the geographical elements have been ameliorated with respect to tradition). Unfortunately, there is only one surviving copy of the original in Arabic, however the document in sufficiently good conditions to enable to reconstruct a "map of the world" according to the measures in the text.

Leonardo Fibonacci (1170)

He was encouraged by his father Bonacci (from which the surname Leonardo is known with stems, meaning son of Bonacci) to take up the profession of merchant, hence Leonardo Fibonacci travelled over several foreign countries, including Egypt, Syria and Greece. He took advantage of this opportunity, concentrating himself on the study of the mathematical techniques employed in those regions. The "Liber Abaci", containing the arithmetic and algebraic knowledge of eastern countries, appeared around the year 1228: this book has the merit to have introduced the Hindu-Arabic numeration system, where the place occupied by the digits affects the value of that digit, into western Europe. This new numeral system replaced the latin one, thereby simplifying commerce and posing the foundations for the future development of mathematics. Fibonacci can be regarded as the forerunner of the conjunction between the "Western" and "Eastern" cultural traditions. Among the numerous advancements brought to mathematics and our *modus pensandi*, we find a particular numerical sequence, known as Fibonacci sequence, in which each number is the sum of the previous two; it was initially developed for its applications in economics and trade, and only later it would be appreciated in its whole generality.

Raimundo Lulio (1232)

Lulio was a philosopher, a theologian, a missionary and a great man of letters. Starting from a theological problem, namely how to rationally demonstrate the veracity of revelation, Lulio formulated the first attempt for a universal symbolic language we have knowledge of. Each simple concept is associated with one or more symbols that, adequately combined through the rules of the "Ars Magna Generalis", yield all the more complex concepts. Lulio was convinced that every truth of science, of faith and even the existence of God could be derived from the set of tables he built. During his life he dealt with nearly all of the known disciplines, from medicine to linguistics, physics and mnemotechniques. Concerning this last subject, he wrote a book that will give rise to a very important school of studies in the Renaissance. He embarked in many journeys aimed at constructing schools for the purpose of studying languages and eastern cultures and at establishing Christian communities in Africa and in the Middle East.. The circumstances of his death are rather mysterious: he probably died of oldness, but according to a legend, in his last travel to Africa for an apostolic mission he was stoned by a local population and thrown on a ship directed to Genoa.

Andrea Mantegna (1431)

He was born in Padua, a focal point for the cultural and artistic activity of his time, and at the age of ten he started his formation as an artist at the workshop of the painter Francesco Squarcione who was very fond of classical archaeology. The knowledge of ancient art was a foundational element in the construction of his highly sophisticated technical and artistic system. In the years he worked as a painter, the theme of perspective was already a central one, although in an embryonic phase. The matter of debate was whether the perspectival structure of the painting should be determined on the basis of the effective position of the viewer or rather if it is the viewer's task to put himself in the ideal position with respect to the structure of the work of art. Mantegna undoubtedly supported the former of the two theories and he became one of the first artists to understand the power of perspective in its complexity: by means of it, it is possible to dilate the visual field of an architectural space, thereby creating that distinct illusionistic effect called "*trompe l'oeil*", or trick of the eye. The earliest evidence of this technique has been found in the Egyptian pyramids and later in Greece and ancient Rome (here it is fully shown the importance the study of the classical culture Mantegna undertook thanks to his master Squarcione). Through the skilled use of perspective and optical effects, this particular technique gives the viewer the substantial illusion (at least at first sight) to see something that is not there. For the creation of an illusory space, Mantegna, following in the steps of Giorgio Vasari, employed and came to master the technique of foreshortening (the perspectival vision) from below, a major innovation of his painting and a legacy for posterity. A well-known example is the painting called "Lamentation over Dead Christ", a work that is still capable of surprising the viewer for its striking originality and realism. But it is with his masterpiece the "Triumphs of Caesar" that Mantegna gains our most unconditional admiration: more than a historical commemoration , it is a scenic representation, we may define as "Fellinian", using many symbols in an ironic sense. More than that: the art work is perhaps the first attempt to induce the viewer into self-reference, with its figures masterly looking "out of the painting".

Lorenzo de Medici (1449)

Lorenzo de Medici was the ruler of Florence, a literary man of superb culture, a diplomat endowed with impressive realizational and organizational capabilities (since his earliest age), as well as an internationally renowned patron of the arts. At the age of twenty, following the premature death of his father, he rose to power and he managed to escape to the famous "Pazzi Conspiracy", in which his brother Giuliano was killed. In just three years, he cleverly reformed state institutions as to maintain peace and balance among the ever-struggling families. He granted himself absolute power without losing popular consent, adopting from the very beginning liberal and rational social and economic policies. He was an impartial judge and he advocated the necessity of balance in the public context and in politics. Lorenzo loved to surround himself of the best personalities of his time, which demonstrates his superior artistic sensitivity for which he was deservedly given the title of "Magnificent". He even established a school for young artists in an estate owned by him, which is recognized as the first Art Academy in Europe. And as if that was not enough, he was also a poet: his elegantly written works reveal a clear vision of reality, the absolute centrality of love as primary source of happiness, and the joy of living in beauty and youth. A poem that is particularly representative of his thought is the one starting with the famous stanza: "Quant'è bella giovinezza, / Che si fugge tuttavia! / Chi vuol esser lieto, sia: / Di doman non c'è certezza".

Leonardo da Vinci (1452)

It is a particularly difficult task to capture the essence of the greatness of Leonardo da Vinci for us men of the 21st century . Furthermore, it becomes increasingly complex with every decade gone by. Whether we are aware of it or not, we are more and more "Vitruvian men". Leonardo possessed an exceptional logical mind and an almost equally extraordinary realizational mind, coupled with what is probably the greatest analogical brain ever to participate the Game. As it is inevitable for a truly great player, he has been concerned with practically everything, with no prejudice whatsoever. He tried to understand, and often to reproduce, any manifestation of the real, not neglecting the search for its ultimate laws, and the interpretative keys, both logical and analogical, of the functioning of reality. When we read that Leonardo was a strict vegetarian we don't sufficiently elaborate on the real implications of such a characteristic: after all, also many of our acquaintances are so! When we observe that all his notes are written in "code", it is effortful to come to an understanding of its importance: are we in the civilization of cryptography or not? The spinal cord is connected to the sense of touch; the reflected images get smaller with distance; the universal deluge, as many other episodes in the Bible, is not to be intended literally; "necessity is the theme and the inventress, the eternal curb and the law of nature". All this is obvious as well, isn't it? If you told these things to the people of the fifteenth century, it would take a miracle barely to stay alive; and it would be totally impossible, unless you are Leonardo, to be honoured and sought after by the main European courts. If you accept the challenge, don't forget to dissect corpes in order to study the human body, to design and realize artificial fluvial channels and, in your spare time, to paint "la Gioconda" and "The Last Supper...

Erasmus da Rotterdam (1466)

His real name was Geert Geertsz that was later translated into latin as Erasmus (from the pseudonym he employed to sign his writings, Desiderius Erasmus) from Rotterdam (his home town). After attending one of the harshest and sternest schools of his time, he was ordained as priest, but later he refused to become a cardinal due to his severe condemnation of the excesses of the Catholic Church: it would not be the sacraments to guarantee the eternal life, but rather the faith in Christ. His need for independence and freedom led him to constantly avoid any constraint or bond limiting his own expression (for instance, he refused any compromise with the academic world, although he was one the most prominent figures in the intellectual movement of the time). It was with "The Praise of Folly" that his greatness became manifest; in an epoch dominated by the often irrational and constraining strictness of Scholasticism, Erasmus gave birth to what we might define as theological satire. In this genius work it is the folly itself that talks to us and, while describing its own nature, it makes a mockery of the audience. The core of the satire lies in falsehood, typical of the clergy and the intellectuals of the time, taking the place of the unconditional truth of human soul that accepts and comprehends what is truly important in life and what is not. Happiness is given by the "lack of sense", namely the pursuit of what is pleasurable and that the so-called wise disdain. Thanks to folly, youth is prolonged, joyful relations, of any kind they might be, are possible, the creativity of the genius can develop, more risks are taken and more can be learnt from them, and, above all, it is possible to gain salvation in the time of suffering.

Niccolò Machiavelli (1469)

He was born in Florence and he started his political career at the age of thirty: during the course of his life, not only he performed offices in his home town, but he also served as an ambassador in France, in Germany and at the court of the pope. In his most important work, "The Prince", Machiavelli provided the ruler with a vast array of practical and theoretical advice to efficiently run the state, obtain the consent of people, face the crises and above all, to most effectively exploit power, successfully managing the problems connected to it. With his contribution, modern "political science" emerged for the first time as an independent discipline, thus separated from other fields of knowledge such as conventional ethics and religion. However, such independence does not imply the absence of morality: in his work, Machiavelli moved from an objective analysis of reality, trying to identify the most appropriate tools to deal with it, starting with the correct behaviour of the prince. He effectively examined what today could be termed "the damages of demagogy", as well as the relevance of the individual component in the flow of historical events. As all the great players, he was unbiased and he aimed at employing his intelligence for the utility of all. Machiavelli is one of the authors undergoing the destiny of being quoted by people who have never read him. The sentence "the end justifies the means" not only was never written by Machiavelli, but what's more is its distance from the essence of his thought: the state he contemplated is based upon the "Prince's Virtue" and it is a state that is strong to be free, governed with intelligence and character, and aimed at achieving consent, peace and prosperity for all. According to Machiavelli, in order for this objective to be met it is necessary to treat men as they really are and not as we would like them to be. If we want to pursue the common good and not just our own personal interest, how is it possible to disagree with this simple rule?

René Descartes (1596)

In spite of his great notoriety as an intellectual, René Descartes' professional career began with the practice of law. However, few years later he abandoned the legal profession as he was impressed by the groundbreaking writings dealing with the foundations of the new scientific thought developed by Galileo Galilei. Thenceforth, his researches led him to explore several fields of knowledge, making critical contribution to the advancement of numerous disciplines. . He started with music and, subsequently, he moved to the study of the mind, then the world, man, geometry, philosophy and the soul. Descartes was an extraordinary source of innovative ideas: from the significance of doubt as the fundamental tool of knowledge, to his differentiation between innate, adventitious and fictitious ideas; from the spatial coordinates as a system of representation of knowledge, to the concept of measure of truth and much more. We will perhaps always be left with the absence of a sufficiently organic systematization of his thought that Descartes failed to provide both because of his conflicting relations with the Church (despite his attempt to provide a rational demonstration of the existence of God, his works were placed in the Index of Prohibited Books) and due to his firm (and, to us, wrongful) conviction that mind (*res cogitans*) and body (*res extensa*) are separate. Descartes spent the last year of his life in Sweden, working as a teacher for the queen who forced him to wake up very early every morning and to face the harsh Scandinavian temperatures. He died at the age of 81 due to a severe pneumonia.

Blaise Pascal (1623)

Pascal stands as a distinctive figure within the cultural context of the seventieth century. Gifted with a precocious intelligence, during his life he revealed remarkable skills in mathematics, probability calculus, geometry and physics, contributing to the discovery of laws and the formulation of innovative theorems. He was not yet twenty when, in the attempt to facilitate his father's work, he designed and constructed the first prototype of a mechanical calculator capable of automatically adding, subtracting, dividing and multiplying many figures. Inspired by the toothed-wheel device of common use among clockmakers, he invented his famous Pascaline that, after a few refinements, was even put into sale. At the age of twenty-seven, following an accident with a carriage from which he escaped miraculously uninjured, he decided to abandon any scientific speculation to devote himself to the study of theology and philosophy to which he remained dedicated for the rest of his life.

Isaac Newton (1642)

It is hard to think of one man of science having such a considerable influence on our vision of the world as Isaac Newton. He was an outstanding mathematician who first showed in concrete terms the famous metaphor of Galileo Galilei: the book of Nature is indeed written in the language of mathematics! Thanks to his theories the "quantitative" vision of the world has both been confirmed and given momentum. Newton's extraordinary intellectual vitality was certainly not paralleled in his life that was rather quite. He graduated from *Trinity College* of Cambridge and, during the 18 months in which the university remained closed because of the plague, he started developing his studies in optics, mathematics and the theory of gravitation. As far as the first discipline is concerned, Newton was the first to demonstrate how white light could be decomposed into a spectrum of different colours, showing that colours are the result of the interaction between objects and light rather than generated by objects themselves. Moreover, he refined the technology of telescope, explained the formation of rainbow and proposed a corpuscular theory of light, which however, for many centuries, did not enjoy much support (the Newtonian intuition will be only partially vindicated by quantum physics in the twentieth century). If his results in the field of optics are those of an excellent scholar, his outstanding achievements in mathematics rightfully gained him immortality: he was the first to engage in the development of infinitesimal calculus. His researches were published with considerable delay, a fact that exacerbated the controversy over priority in the invention between the English mathematicians in support of Newton and those on the continent on the side of Leibniz. "Philosophiae Naturalis Principia Matematica" was published on 5th July, 1687: in this work Newton developed the three laws of motion that will form the basis of mechanics up to 1900 and the law of universal gravitation. The understanding of the motion of both celestial and earthly bodies was masterly unified: the philosophical and mathematical work of the most prominent European scholars at the cusp between the sixteenth and seventeenth centuries found its sublimation in Newton's ingenious work, bound to become the strongest promotion for heliocentrism and the newborn Enlightenment philosophy. Although mathematically exceptional, the theory encountered some philosophical resistance in its early years of existence; if, on the one hand, some thinkers such as Leibniz considered the presumption of an absolute space and time as incomplete, on the other, several physicists and philosophers remained skeptical about the idea of a force instantly operating at distance, as in the Newtonian equation for gravity. The famous mathematician and physicist Christiaan Huygens even came to pose the rhetorical question of how was it possible to waste so much good mathematics for such a theory (and, among other things, Huygens had developed the basic mathematical tools of infinitesimal calculus). However, over time, the spectacular experimental successes of the ideas formulated in the Principia prevailed over the philosophical oppositions and the work became "the Book of Physics" for the next two hundred years until the advent of the theory of relativity and quantum physics. Newton was a passionate commentator of the Bible, hence a very different from that hyper-rationalist figure portrayed by the Enlightenment; on the contrary; the introduction of the law of gravity, which was so harshly criticized by Cartesian supporters, represented to him a welcome recognition of how wrongful the determinists and the mechanicists of the time were: "Gravity explains the motion of the planets, but it cannot explain who set the planets in motion. God govern all things and knows all that is or can be done". There is a notable description of him amusingly, and not without foundation, stating that "Newton was not the first of the age of Reason, he was the last of the Magicians".

Gottfried Leibniz (1646)

The enterprise of drawing up a ranking of the great players is obviously an impracticable one. Nevertheless, if there is one player that we may confidently place in the highest positions, irrespective of the hierarchical criterion applied, it is Gottfried Leibniz. Leibniz was one of the most intelligent and gifted people ever to participate to the Game. He studied and thought about practically everything with the constant goal of understanding and measuring the basic rules and, when possible, reproducing them. In sum, a great logical, analogical and realizational genius. By means of his logical mind he arrived at an in-depth investigation, just to make some examples, of such concepts as function, integral calculus, derivative, limit, binary arithmetic, retroaction, identity and symbolic reasoning. With his ananlogical mind, he analyzed, and, again, these are only some examples, the mind-matter dualism, the ultimate functioning of physical reality, the meaning of art, the concepts of good and evil, of innatism and of universal language. Finally, thanks to his realizational mind, he was a first-rate diplomat, and as a historian and an economist he was listened to and appreciated in many European courts and by the founding fathers of the newborn American nation. More than three centuries later, we can state that his logical mind was never wrong, that his analogical mind suggested hypothesis still worth examining and that his realizational mind favoured the development of a societal model based on freedom and the individual; one that, as to paraphrase a famous statement of his, we can still consider as the best among those available.

Jakob Bernoulli (1654)

Migrating from Belgium to Switzerland in the sixteenth century, in Basel, Leon Bernoulli transplanted a family bound to generate numerous talents in the arts and sciences: these outstanding figures in the history of mathematics seem to prove the saying "blood will out". Jakob Bernoulli is one of the eight mathematicians of the family. He was the son of Nicolaus, a preeminent member of the city council, and, under the pressure of his family, he studied philosophy and theology; however, in the course of his studies at the Basel University, he started developing his interest in mathematics and astronomy. After he had graduated in theology, Bernoulli traveled troughout Europe for almost ten years, meeting many notable scholars and mathematicians of the time with whom he often established personal correspondence and collaboration relations. A turning point in his life was the request on the part of his brother Johann Bernoulli, a medician upon his parents' desire, of being initiated into advanced mathematical studies. The Bernoulli brothers belong to the very restricted circle of European scholars who fruitfully confronted themselves with Gottfried Leibniz' original work on calculus. However, the idyll did not last long: following Johann publicly boasting of his abilities, Jacob described his brother as a student merely repeating his master's thought. Their relationship was spoilt since then: it is hard to determine whether their rivalry fostered the extensiveness of their work or if their cooperation might have resulted in even better production. In 1690, it was a paper by Jacob to introduce the term "integral", demonstrating his already profound understanding of the concept. In 1696 he was the first to solve the equation now named after him "Bernoulli equation", that is $y' = p(x)y + q(x)y^n$. Nevertheless, his undisputable masterpiece is the "Ars Conjectandi", posthumously published in Basel in the year 1713. In this work, left incomplete, Bernoulli, besides developing new and independent demonstrations for already known results, articulated some key concepts in probability theory ("probability as a measurable degree of certainty") and he presented some applications to various games of fortune. Not only this, the famous Bernoulli numbers appear in the book within a discussion of exponential series; furthermore, the Ars contains the first formulation of the so-called "law of large numbers". He remained a professor in Basel until his death, in 1705; the successor to his position was obviously his brother Johann. Engraved on his tombstone are a logarithmic spiral, which he viewed as an almost magical object and had renamed "*Spira mirabilis*", and only three words: *Eadem Mutata Resurgo*.

David Hume (1711)

Originally his name was David Home, which he later changed into Hume because of the English having difficulty in correctly pronouncing his Scottish surname. Hume was a very precocious child and, already at twelve, he began attending the university of Edinburgh with his elder brother. He was only twenty-six when he completed his first treatise, the "Treatise of Human Nature": as it is often the case with brilliant works, his contemporaries' response was rather tepid, although it contains the renowned Hume's "new perspective of thought", namely the theory of causation, together with many other original arguments. From 1748 he started to write his second great treatise that would be published as "An Enquiry concerning Human Understanding", with not a much greater editorial success than the Treatise, despite the memorable closing lines: "If we take in our hand any volume; of divinity or school metaphysics, for instance; let us ask, Does it contain any abstract reasoning concerning quantity or number? No. Does it contain any experimental reasoning concerning matter of fact and existence? No. Commit it then to the flames: for it can contain nothing but sophistry and illusion". Therefore, it doesn't come as a surprise that in 1752 he was denied the chair of philosophy at Glasgow, apparently also due to his (anti)-religious ideas. After a few years spent in Paris, in 1768 he returned to Edinburgh, where he died eight years later. Philosophically speaking, David Hume can be defined as the skeptic par excellence: his arguments questioned many of the most deep-rooted beliefs of his time (and of ours as well). For instance, Hume's theory of causation was a radical departure from the other philosophers: Hume held that anything occurring in nature is a sequence of phenomena, with no cause nor connection whatsoever: what happens is that, inasmuch as we are accustomed to see a certain class of events (the break of a glass) after some other type of events (a ball being thrown towards the window), we infer that the former was caused by the latter. By leading many issues away from the field of traditional metaphysics into the ground of man's cognitive operations, Hume managed to demystify concepts such as induction, miracle and Cartesian soul, to formulate the first argument against the theory of "intelligent design" which is a very popular object of study in the fields of politics and economics, and to give a significant contribution to downsize the claims of a rationalist moral reappraising the impact of the non-logical components of human action. It was only in the later years of his life that his fame started to spread among philosophers, mainly thanks to Immanuel Kant who, in one of his works, expressed his gratitude to Hume for wakening him up from his "dogmatic sleep". His grave was marked by the epitaph he wrote himself: "Born 1711, Died…Leaving it to posterity to add the rest".

Immanuel Kant (1724)

Throughout the book we have often maintained the opinion that only truly clever people are able to understand and, most importantly, to divulge the thought of great geniuses. Undoubtedly, Immanuel Kant stands out amidst those great thinkers whose ideas can be understood in the essence, and hence explained, only if one possesses an adequate intelligence.

His manner of expression, however rigorous, is objectively difficult. It might be effortfully dealt with by a logical mind, whereas it is close to the impossible for an analogical mind. And that's a pity, because Kant was markedly one of the most lucid and innovative players ever to participate the Game. We owe him the first review of the concept of religion as "the most beneficial error into which human reason could ever have fallen". His is the understanding of how a "rational ethics" is much more solid and reliable than a religious or a political ethics. His is also the first fully fledged model of human mind. He was so intelligent that many successors, less skilled than himself, took several statements of his literally, without comprehending their true meaning, for instance, to the point of concluding that "only thought creates the world". On the contrary, Kant was the first to clearly (so to speak…) state the concept that "we can never know things in themselves, we can only know what tings are for us", or, in our language, "there exists the real that is composed of everything existing, and there exists our mind that observes and describes it": in a sense, it marked the birth of our concept of "model of reference". Like all the greatest of the past, Kant experienced his time as an hindrance:: some days before his death, he came to describe his psychological condition of inadequacy with respect to the Solution to the Game as a real Tantalus' torment. To us there is one particularly tantalizing fancy among all possible ones: we would like to see Gödel's theorem metabolized within Kant's "transcendental subject", and his "empirical subject" with an adequate one-love by its side. Who knows what new ideas he might have offered and what different a life he would have led! Is this closing remark not clear to everybody? Well, it's Kant we are talking about!

Jean-Baptiste Lamarck (1744)

The studies of Jean-Baptiste Monet, chevalier de la Marck, encompassed nearly all natural sciences, from chemistry and biology to physics: one of the things we like to stress is that the dichotomic method for the classification of plants he conceived is still employed today. It was mainly the bewildering fossil findings (the discovery of unknown animal species started in those years) that led Lamarck to develop the firm belief in the profound inconsistency of the fixist theory on the birth and development of the living, resting on the assumption that all species were created by God upon the act of Creation. On the contrary, according to Lamarck, the living would be a product of nature whose formation dates back to later times: the simplest organisms originated and originate from inanimate matter and, as they encounter favourable conditions, they tend to progress in complexity. Starting from this point, Lamarck was the first to assume the possibility of evolution of the species (although very different from the hypothesis put forward later by Charles Darwin) and he developed his out and out theory of the heredity of acquired characters. The underlying idea is simple and intuitive: when living beings undergo environmental mutations, their organic fluids flow towards the part of the body that is better equipped to produce the most appropriate action meeting the specific need of the moment. Therefore, the change experienced by the individual is passed on to its offspring: as different generations of giraffes stretched their necks day after day, giraffes eventually reached the optimal height. In this manner, Lamarckian theory is able to account for how continuous adaptative transformations might occur with a constant increase in "perfection". Lamarck's two great ideas experienced totally opposite fortunes in the subsequent scientific development: almost nobody (apart from us) has followed him in maintaining the possibility of transmitting to the offspring not only the genotype but also the acquired characters, whereas nearly everybody (from Darwin on) has abandoned Linnaeus to conduct biological studies under the perspective of the evolution of the species, an evolution that is continuous and unending towards an increasingly better adaptation to the environment and its modifications.

Carl Friedrich Gauss (1777)

Princeps mathematicorum, the prince of mathematicians, was born into a family of modest means in Brunswick. Legend covers his early steps in mathematics and in life as well: however, every biography reports the anecdote of a three- year-old Carl Friedrich Gauss correcting an error in a financial calculation made by his father. In primary school, in a few seconds he solved the problem the teacher had assigned to the class, namely, computing the sum of the first one hundred integers, realizing that such sum equals 101 times 50. In 1796 he showed how to construct a regular polygon with 17 sides, that is, the major innovation in the field since the times of Greeks: it is told that the beauty of this construction persuaded him to devote himself to mathematics rather than philology. A scholarship enabled him to carry on his mathematical studies: in his doctorate dissertation he gave the first proof of the fundamental theorem of algebra (any equation equivalent to a polynomial of one variable with degree n equalized to zero admits exactly n solutions in the complex field); in 1801 he published the book "Disquisitiones Arithmeticae", which is regarded as a supreme masterpiece in the realm of number theory. Nevertheless, the desire for a less precarious financial position, his work on Ceres and the notoriety that followed led Gauss to drift away from pure mathematics. In fact, in June 1801, a new celestial body, i.e. Ceres, had been observed for a short time only; many predictions of where the body would be located again were formulated, and among these the most accurate was Gauss's one. When the planet reappeared in

December, it proved the mathematician right (in order to predict the position, Gauss employed an approximation method that he had devised himself some years earlier and still used in several applicative fields, namely the method of "least squares"). At this point, the time was ready for him to concentrate on something else: in 1807 he was appointed director of the observatory of Göttingen and, two years later, he published a two-volume treatise on the motion of celestial bodies. His interests were in constant evolution: in 1818 he conducted a large- scale geodesic survey in the state of Hanover. The invention of the heliotrope, an instrument that uses the reflection of solar rays for measurements, stemmed from this experience; most importantly, here we can find the roots of both the well-known "Gauss curve" and the interest in differential geometry. Gauss curve (also known as "normal" or "Gaussian" function) is probably the most meaningful statistical function to explain and predict biological phenomena. He became acquainted with Alexander von Humboldt, who was seeking help to create a network of observation points to measure earth's magnetic field, and this connection encouraged him to elaborate a general theory of earthly magnetism. Also in this domain, Gauss' studies of the 1830s led to remarkable results, such as, for instance, the specification of the location for the magnetic south pole. It is astonishing to realize that his, however outstanding, publications are but the tip of the iceberg of the activity carried out by the mathematician: due to his perfectionism, Gauss never published nor shared his ideas and intuitions, unless they already possessed a flawless mathematical form. Over the subsequent years, as his notes progressively came to light, it became clear that many mathematicians had spent years in the attempt to demonstrate again what he had independently proven years (and often even decades) before. The most extraordinary case, in this respect, is undoubtedly that of the non-Euclidean geometries, whose discovery dates back to his adolescence. Gauss, who is considered by numerous mathematicians as their most prominent colleague, died on 23 February

1855. According to the accounts, he requested a regular polygon with 17 sides to be inscribed on his tombstone.

Charles Babbage (1791)

Charles Babbage was a mathematician, philosopher and scientist who must be credited for being the first to think out the possibility of constructing a programmable computer. While still a student at Cambridge's *Trinity College*, where he graduated in mathematics, he was toiling on the logarithmic tables, effortfully (and at times mistakenly) computed by human mathematicians, when he first dreamt of a mechanical device that would be capable of rapidly and reliably performing functions that men could only accomplish slowly, with difficulty and many errors. Babbage's first project, presented at the *Royal Society* in1822, was the difference engine, a calculator capable of executing operations useful to mathematical and astronomical tables. The following year the government allocated 1500 pounds for the machine, but the construction resulted more troublesome than expected; on the one hand, the technical tools of the time failed to remove all the vibrations of the gears and their frictions; on the other, Babbage is told to have had frequent arguments with the mechanics responsible for the assembly. It is only 200 years and 300.000 pounds later that the calculator saw the light: since 1991 the London Science Museum has been displaying a difference engine constructed according to Babbage's design. His second idea is conceptually even more revolutionary and ingenious: between 1833 and 1842, he devoted his work to the analytical engine, a machine capable of being programmed to execute all sorts of instructions, not merely calculations for the astronomical tables. In fact, Babbage was enlightened by the invention of the new looms that could weave patterns according to punched cards. According to Babbage's plans, the analytical machine would have used punched cards as input, it would have been capable of processing numbers and endowed with a memory and an output mechanism. In 1837, a concrete project for its realization was finalized, but the construction process was even more unfortunate than for the previous device. The contribution of a young mathematician, Ada Lovelace, who created several programs for the engine, was not sufficient to carry on the project. In 1842, after a further rejection by the British government to provide new funds, this story also came to an end. for Babbage. For Babbage, but not for us: eventually, even this story had its, perhaps less romantic but infinitely more useful, happy ending. About a hundred years later saw the birth of analytical machines, punched-card programmable calculators: the first computers.

Ernst Heinrich Weber (1795)

The German physiologist Ernst Heinrich Weber is famous for his studies on human sensorial apparatus, nevertheless throughout his life he also focused his researches on the physics of fluids, the elasticity of vessels in blood circulation and the inhibitory ability of the vagus nerve on heart beat. His major contribution to physiology was the formulation of an important law that is named after him. Such law asserts that "the difference between two stimuli is sensed as a function of the intensity of said stimuli". For instance, a 1-Kg increase in an object weighing 5 Kg is perceived with greater intensity than in the case in which 1 Kg is added to an object whose original weight is 30 Kg. His work was of paramount importance for Gustav Fechner and the birth of psychoneuroimmunology. Furthermore, Ernst was not the only scientist in his family: in fact, the name Weber is also associated with the history of electromagnetism thanks to his younger brother Wilhelm.

Gustav Theodor Fechner (1801)

Fechner was an all-round scientist. He was a German physicist and mathematician, and is recognised as one of the forerunners of psychology. His research was immediately focused on the construction of a "science of the soul". Fechner benefited from a long tradition handed down from the Pythagoricians until the humanist culture. He attempted to demonstrate the possibility of general relations between the physical world and psychic life. Hence, he was led to strongly support psychometry, through which he tried to measure some aspects of the psyche using the instruments of physics. Taking up the studies of his colleague and friend Ernest Weber, he managed to determine with greater precision the relation between differing stimuli and sensations. He laid the foundations of psychophysics, namely the discipline that investigates the interactions between physical stimuli and their respective sensations. In 1836, while conducting some experiments on the residual images produced by continuous and prolonged staring at sunlight, he severely damaged his eyes. After this accident, he decided to retire from the academic world for three years. Fechner's work had a major influence on his successors; therefore, he is justifiably numbered among the greatest precursors of psychoneuroimmunology by all the insiders of the field.

Charles Darwin (1809)

Forced by his father to study medicine, Charles Darwin soon concentrated his interests on natural history, zoology and botanic. His disappointing academic results induced his family to direct him to an ecclesiastic career, an environment that enabled Charles to pursue the studies that truly held his interest. At the age of thirty, he embarked as a naturalist on a scientific expedition to some of the most exotic islands in the world:

in 1839, thanks to the diary he had written throughout the journey., he finally gained some notoriety. Before the advent of Darwin, it was Jean-Baptiste Lamarck who had developed the best evolutionary theory based on the inheritance of acquired characters (living in a certain environment induces alterations in the body of the individual as to improve his adaptation to the environment, such changes are passed on to the offspring who will be more and more fit to that particular environment). Lamarck's theory is intuitive, but it has several problems: first, the transmission of inherited characters has never been supported by experimental evidence; second, the theory fails to provide an explanation for the variety of the species given the continuous adaptation to the environment. The genius of Darwin's idea stands in his formulation of a design drawing together the most diverse elements that the naturalist came to know in the most heterogeneous ways and places: the exotic journeys and the observation of birds; the existence, in every population, of individuals slightly different from the average (spontaneous variations); the elevated rate of mortality present in nature; breeders' ability to select the most convenient variations of animals (artificial selection); finally, the ideas of some prominent economists of the time (in a nutshell: if all survived, there would not be enough space for anybody). Darwin arrived at discovering two simple, but opposing, mechanisms capable of accounting for two fundamental biological facts: on the one hand, the huge variability of living species, and on the other hand, their common origin. According to the naturalist, Mother Nature populated the earth through mutation and selection. The former process is at the origin, for example, of spontaneous variations: now and then, random mutations in the generation of offspring occur. The latter, which is operated by the environment, led to the extinction of the great majority of the species appeared on the planet. Nature is something of a contest: mutation provides the potential contestants, thereby guaranteeing the production of ever-changing projects, whereas selection evaluates the candidates, discarding the unsuitable ones. In other words, the environment behaves just as a breeder: it assigns different reproductive capabilities to the diverse individuals in a certain population at a given time. Although the norm is punitive for the varying individuals (since the "normal" usually are already fairly fit), at times, their characteristics might result better, and hence they end up supplanting the old population. In spite of appearance, it is neither a mystery nor a miracle that all the present living beings descend from a small group of primordial organisms, from mutation to mutation and from selection to selection. The Darwinian theory of selection is not only an improvement of the previous evolutionary theories, but it also stands as the single most important idea of biology, besides being one of the most elegant and effective reductive explanations ever produced by man. The publication of "On the Origin of Species" in 1859 (after more than twenty years of pondering) marks a momentous step forward in the path to the comprehension of Reality for the whole humanity.

George Boole (1815)

George Boole was born into a family of humble means at Lincoln, in England. He was taught the first rudiments of mathematics by his father, he learnt Latin from a family friend and Greek as an autodidact. His school career was practically non-existing: after primary education, his parents could only afford a commercial school, the *Bainbridge's Commercial Academy*. George learnt himself what school did not teach: aged 14, he had learnt German, Italian and French. It is surprising that a mathematician of such stature never came to possess any academic title; in spite of everything, at 16 he was already an assistant in a private school at Doncaster. All his life he sustained himself passing from one scholastic post to another: in 1849, he was appointed professor of mathematics at the *Queen's*

College in Cork, a position he held until his death. In 1839, at barely 24 years of age, Boole wrote the first of the twenty-two articles he would publish on the *Cambridge Mathematical Journal* and he started cultivating relationships of friendship and esteem with some of the most distinguished scholars of the time, among whom Augustus de Morgan. In 1859 and in the following year, he produced two works of a thoroughly mathematical character: first the "Treatise on Differential Equations" followed by the "Treatise on the Calculus of Finite Differences". Notwithstanding the relevance of these books, the far most significant work of the English mathematician was in the field of logic: it is in 1854 that Boole published, under the eloquent title "Investigation of the Laws of Thought", his theory on "the algebra of thought". He was the first to show that Gottfried Leibniz' dream could be fulfilled: it is possible to represent thoughts, logical connectives, Aristotelic syllogisms and other types of inference by means of numerical symbols and purely algebraic operations. The new system made evident that the logical relations between thoughts can be reduced to manipulations of symbols, provided that one can find an adequate way of representing the former through the latter. It is only decades after Boole's methods had disappeared that it became manifest that the mathematization of thought was the natural and necessary prelude to a new, fundamental stage in human progress: the mechanization of thought. If we think "combinatorially", the same can be done by any device possessing the appropriate rules and symbols to represent the mental contents. If artificial intelligence is what naturally comes to mind at this point, it must be stressed that the applications of Boolean algebra constitute the very core of *computer science* down to its building blocks, hardware and software: on the one hand, digital circuits are programmed with AND, NOT and OR gates; on the other, every programming language makes an extensive use of Boolean operators, from bit-to bit operations to the control of the flow of programs.

Ada Lovelace (1815)

In a world dominated by male figures, such as informatics (both practical and theoretical), oddly, it was a woman, Ada Lovelace, who must be credited for writing the first software. Ada's mother was frightened by the thought that the daughter could follow the poetical career of her father, George Gordon Byron, hence she pushed her to study mathematics from an early age. Continuing her studies, she ended up being a direct pupil of Augustus de Morgan at the London University. On 5 June 1833, she was introduced to Charles Babbage, a visionary widower aged fifty-one, who was bound to be remembered by posterity as the grandfather of computers: it was the meeting that changed her life. Ada began to take an interest in Babbage's ideas and projects of mechanical calculators: she translated into English and discussed some texts on the subject and she started a fruitful correspondence with him. As it can be appreciated from the article published in 1843, Ada had a very clear understanding of the idea of algorithm and acutely recognized the potential of a programmable machine, namely capable of executing any set of adequate instructions which it is provided with. And more than that, in her notes she formulated an effective method for calculating Bernoulli numbers with Babbage's analytical engine. This algorithm is recognized by historians as the first example of software in history. Ada's forward-sightedness led her to assertions that are even more revolutionary and discerning than Babbage's statements: in fact, machines would be capable, if adequately programmed, to "compose musical pieces of arbitrary complexity and length". Undoubtedly one of the most picturesque and fascinating figures in the history of *computer science*, Ada Lovelace died at only 36 years old, probably from uterine cancer. Recently, a programming language developed by the United States Department of Defense, was named ADA in her honour.

William James (1842)

If you ask a European to spell the name of the first author which comes to her mind in connection with the word psychology, most probably, the answer will be "Sigmund Freud". Instead, if the same question was put to an American, "William James" would be the most likely answer. In fact, William James, under many aspects, had an impact on the American culture which is comparable to that of his European colleague. He was the son of a philosopher and the brother of a prominent novelist and he devoted his entire life to the study of man: although we often tend to speak of him as a philosopher, a psychologist or a physician for schematic reasons, these three souls constantly provided a continuous and consistent contribution to his thought. His scientific research developed within a well-defined philosophical framework, namely pragmatism (a movement that saw him among its founders): the fundamental idea is that knowledge builds only upon the facts of experience. At the same time, the psychological approach that underlies his inquiry rests on the considerable biological knowledge he acquired during his formation as a physician. He spent his whole academic career at Harvard University, where, among other things, he founded the first department and laboratory of psychology. His research is oriented to the study of the mind-body relation: his interest in the Darwinian theories date back to his school years, and James's early writings were devoted to identifying an explanation of the effects of natural selection on the human mind. Subsequently, he formulated his renown theory of emotions, which maintains that emotions are dictated by reactions in the visceral organs provoked by the cortex in response to particular events. A few years later, he published "Principles of Psychology", a work that synthesized his genetic, neurophysiological and phenomenological researches, according to which psychic reality is held to be a stream of consciousness that must be described in its spontaneity beyond superstructures. In his later years James focused on the investigation of the mind-body problem also from a transcendental perspective, in particular with the study of those forms of religious experience which bend to mysticism. His voluminous literary production brims with numerous maxims. Notably, there is one we have always deemed as particularly close to our approach: " our self-feeling in this world depends entirely on what we back ourselves to be and do".

Friedrich Nietzsche (1844)

Friedrich Nietzsche advocated "faithfulness to earth", he explained "how one becomes what one is", he encouraged a philosophizing "with the hammer", he howled that "God is dead", and much more. He might not be the most studied one, but he is undoubtedly the most manipulated, misinterpreted, quoted and controversial philosopher in history. He came to be the ruthless analyst and, in some respects, the destroyer of all those values which the West considered itself to be founded on at the half of the Nineteenth century: among them, truth, science, religion, progress, good, morality. His advent into the world of philosophy was marked by "The Birth of Tragedy": standing in decisive opposition to the other philosophers and historicians, Nietzsche characterized the Socaratic turn and the classical age of the hellenic world as a decay, as to rediscover the ideas and motivations of the time before the great Athens of Pericles. After only a few philological considerations, the work presents itself as the key for the interpretation of the whole Western history, starting from what is found to be its origin: tragedy built of the balance between the Apollonian and the Dionysian. The underlying idea is both intriguing and psychologically fascinating. On the one hand, there is Dionysus, the orgiastic god of the wild nature, who is the embodiment of disorder, irrationality, human instinct and desire; on the other hand there is Apollo, the solar god who represents order, rationality and balance. Nietzsche charged Socrates and the classics with disregarding Dionysus to privilege Apollo, thereby vesting reality and man with a rational mantle that actually is nothing but a disguise, or, however, an incomplete one. In order to take up his invitation to rediscover Dionysus it is necessary to fully understand all the "illusions" set by Apollo throughout millennia. In particular, Nietzsche acutely called for the overcoming of traditional ideals as the key to change man and the construction of a new system to shape a new man. He developed his criticisms of traditional morals, from Platonism to Christianity, through the demythicization of those values that seemed divine, eternal, untouchable, showing how they actually are "human, all too human" things. The rules at the basis of our society are not divine emanations, but rather the response to the natural need of man to dominate the reality surrounding him. It is again the Apollonian to operate to cover the Dionysian, causing a further mystification of reality: values such as equality and altruism do not stem from any instances of goodness, but they rather emerge from "slaves" in response to the moral of the masters. Many before Nietzsche had recognized that "good" often equals "useful to the stronger", but nobody had taken the next step: the values proposed by the "weak" are themselves nothing but instruments of oppression that impose a renunciation of life and of Dionysian spirit. The new man, the overman, finds in himself the reasons to justify his actions, rejecting all nonmundane illusions to affirm his own bodily and instinctual reality.

Ivan Pavlov (1849)

He was a Russian physiologist who was awarded the Nobel prize in medicine in 1904 for his studies on the interactions between the nervous system and the digestive apparatus based on experiments conducted on dogs. His name is connected with the discovery of the "conditioned reflex" (or better, "conditional reflex"). The expression "*conditioned reflex*" is the result of a series of poor translations from the original Russian expression. Actually, Pavlov always conceived the mechanism as highly active, rather than passive, in its essence, therefore it is probably more accurate to use the term "conditional". Pavlov's experiment with bells and food is very well noted: through this experiment, Pavlov showed that a secondary stimulus (the ring of a bell) can be easily associated with a primary stimulus (food), which would produce an automatic response (salivation). Following repeated coupling of the two stimuli, the response is also triggered only by the first stimulus: hence, as Pavlov rang the bell the dog salivated. Such discovery produced significant repercussions in the field of psychoneurophysiology: on the one hand, it provided Robert Adler's psychoneuroimmunology with a solid theoretical foundation, on the other, it crucially contributed to the birth of behaviourism. It seems that, consistently with his life devoted to science, at the time approaching his death, Pavlov asked a student to record his vital parameters and their modifications at the moment of his departure.

Henri Poincaré (1854)

The most original contributions of Henri Poincaré extend across a remarkable variety of disciplines: mathematics, celestial mechanics, fluid mechanics, the special theory of relativity, philosophy of science and much more. The young Poincaré bore those that the common sense normally sees as the distinctive signs of a genius: he was very myopic, clumsy in his movements with very poor coordination skills and exceptional in all subjects. At high school he won the mathematics competition among the top students from all over France. After graduating from the *École Polytechnique*, he obtained his doctorate from the University of Paris in 1879 with a thesis on differential equations; soon after that, he was appointed to a chair in physics and probability theory at the Sorbonne, a position he held until his premature death at the age of 58. It is a practically impossible exercise to give account of all his original works: "Analysis Situs" is the first systematic treatise on topology and his following works provided the foundations for algebraic topology; in fact, one of the so-called "Seven Millenium Problems" is the Poincaré conjecture in topology. Besides analysis and number theory, he articulated observations and theories in different fields of applied mathematics, such as optics, electricity, elasticity, thermodynamics and cosmology. Poincaré developed, at roughly the same time, but independently from Einstein, some of the ideas underlying the Special Theory of Relativity, such as the principle of relativity. His paper on these topics was published one year after Einstein's work, who later publicly acknowledged the contribution of Lorentz's equations and Poincaré's studies in the development of the new and revolutionary physical theory. Curiously, Poincaré continued to consider Relativity as "Lorentz' mechanics" throughout his life. In 1887, the king of Sweden established a mathematical competition to celebrate his sixtieth birthday in 1889. The French mathematician won the prize thanks to his research on the three-body problem, one of the greatest cosmological puzzles for physicians since Newton's time: Poincaré did not find a solution to the original problem, but the distinguished value of his work enabled him to win the competition. Further studies on these subjects led him to produce another major work: "Les Méthodes Nouvelles de la Mécanique Céleste" was published in three volumes between 1892 and 1899. In his studies on celestial mechanics, Poincaré was the first to appreciate that the behaviour of even a simple system (such as the three-body one) can be so sensitive to initial conditions that the final outcome is very hard to predict: in fact, although totally deterministic and with no casual element, some systems manifest chaotic and apparently unpredictable evolutions. Also the concept of "deterministic chaos" and the modern mathematical chaos theory are somehow a result of Poincaré's genius (and topology). Recently, his famous conjecture seems to have been solved: in 2003, Grigory Perelman published online a proof which is still under the scrutiny of scientists; yet, the rather eccentric Russian mathematician has refused the one million dollar prize for the solution of the problem, several chairs over the world and the Fields Medal, the Nobel prize equivalent of mathematics. It will take decades to evaluate all the consequences since it is a central problem of mathematics and physics. He was the only member to be elected to each of the five sections of the Academy of Science: geometry, physics, mechanics, geography and navigation. In our research laboratory, we are particularly flattered in being in his company as members of a less official but equally important association, namely, that of the supporters of the discrete dodecahedral space. At his funeral, he was described as "a mathematician, geometer, philosopher, and man of letters, who was a kind of poet of the infinite, a kind of bard of science".

Sigmund Freud (1856)

The founder of psychoanalysis started his professional career as a neurologist. In the view of German neurology at the end of the nineteenth century, clinical diagnosis were based on hundreds of autopsies, which enabled to correlate each disorder with a certain cerebral damage. Nevertheless, it became clear that this methodology did not apply to some pathologies: for instance, the cases of hysteria were unrelated to any detectable damage. Freud started from this observation to formulate an alternative explanatory model. However, it must be pointed out that, at least in Freud's intentions, the departure from neurology was to be only partial: psychoanalysis developed as a means of describing and solving those problems that neurology, due to a temporary lack of knowledge and tools, was unable to tackle. The instruments and the concepts that Freud introduced during over forty years of work have become part of popular culture: the interpretation of dreams, the free associations, such concepts as "Id", "Ego" and "Super-ego", "transference", "libido", but most notably the "unconscious". In order to fully realize the extent of Freudian work, one has to consider that it developed as the first genuine model capable of interacting with the matter through manipulation of information (namely, by means of word and all the tools related to it). Pain, both physical and psychical, accompanied Freud throughout his life, as it was repeatedly suffered by him in person as well as those close to him. As his days came to an end, after suffering twenty years due to an oral cancer, and in agreement with his personal beliefs, Freud asked his doctor to carry out euthanasia for him.

Alfred Binet (1857)

Alfred Binet was a French psychologist, mostly known for being one of the pioneers of psychological testing aimed at assessing intelligence. He formed himself as a neurologist at the *Salpêtrière Hospital* in Paris where he was mentored by one of the most prominent professors of the time, namely, Jean Martin Charcot. Like Sigmund Freud, he attended the hypnotic experiments carried out by Charcot, and, exactly like Freud, this work had such a profound influence on him that he published four articles on the subject. Unfortunately, some of Charcot's results that Binet had supported were disproved, forcing the young neurologist to publicly retract his work. In the mid 1880's the close birth of his two daughters propelled his interest in the investigation of the processes and mechanisms of human development, a field to which he devoted almost his entire life with the publication of plentiful studies and theories that had a considerable influence on, among the others, Jean Piaget. In 1891 he started working at the laboratory of general psychology at the Sorbonne, where he met Theodore Simon who became his most committed collaborator. The year 1904 marked the major turning point in the professional career of the two researchers: they were charged by the Ministerial Commission for the Study of Retarded Children to develop a mechanism to identify the children who needed special education. Their work resulted in the creation of the famous "Binet-Simon Scale" aimed at testing the intelligence of scholar-age subjects. The scale is composed of thirty tasks of increasing difficulty whose selection was based on the observation of children in their natural contexts. The evaluation was based on comparison: a subject was deemed intellectually normal when he managed to perform the tests successfully passed by the 80/90% of the subjects of the same age. It is worth noting the definition of intelligence proposed by the two authors: "It seems to us that in intelligence there is a fundamental faculty, (...) this faculty is judgement otherwise called good sense (...); the rest of the intellectual faculties seem of little importance in comparison with judgement". Resuming the Aristotelic concept of wisdom, judgement is elevated as the primary function of intelligence. Although there have been numerous criticisms directed to the validity of the tests, the breakthrough made by these scientists is to be stressed: their studies opened the door to a prolific season of research and experiments in the field of testing.

Max Planck (1858)

Max Planck's encounter with physics, which was bound to become an exceptionally passionate and fertile union, started as all remarkable love stories do, almost by chance. At 16 Max was undoubtedly good at scientific subjects; on the other hand though, he was cultivating his lifelong passion for music, and he seemed talented as a pianist and an organist. At the question asked him by the young Max on what path to take in life, a professional musician replied that the mere fact of wondering revealed that a career in music was not for him. If it is true that music does not owe much to this man, it is a whole different story for physics. This was the beginning of Planck's academic career that soon led him to decidedly pursue the field of physical research. The underlying reason is simple but convincing, as these words of his clarify: "the outside world is something independent from man, something absolute, and the quest for the laws which apply to this absolute appeared to me as the most sublime scientific pursuit in life". After receiving his doctorate at only 21 years of age, it didn't take long for him to obtain a stable position in the academic world: from 1892 he was a professor of theoretical physics at the University of Berlin, where he worked until retiring from teaching. Planck's most famous discovery in 1900 opened the new century and it was the point of departure for quantum revolution. It was already known to physicists that a body, at a given temperature, emits some radiations, namely its characteristic "spectrum"; furthermore, it was also known that a particular idealized object, i.e. the "black body", emits a spectrum that is independent of its shape and material. Such body is termed as "black" because it is assumed to absorb all electromagnetic radiation incident upon it; its study is deemed to be fundamental to understand the nature of the interaction between radiation and matter. Planck formulated a mathematically satisfactory description of this interaction, making it possible, for the first time, to derive the spectrum of the black body: the "scandal" laid in the fact that such derivation is possible only assuming that the exchanges between matter and radiation are not continuous but rather "quantized". At the time, Albert Einstein was the only one to seriously consider this hypothesis, and five years later he published his work on photoelectric effect. Thereafter, the rest of quantum physics is history. At the end of the First World War, Planck received the Nobel prize in physics for his extraordinary contribution. Since that article, however, his private life started being darkened by tragic events; first the loss of his wife, then the death of his son in war. His later years were marked by trouble: his criticisms caused him the hostility of the Nazi regime and, during the Second World War, Planck refused to hold his public positions in the field of German scientific research. The Allies bombed and destroyed his house in Berlin; his youngest son was executed by the Nazis in 1945 on the accusation of attempting on the dictator's life. The founder of quantum mechanics died on October 4, 1947. In physics there are units of measurement named "Planck units", in honour of the physicist who first proposed them (in the far 1899!): such units are exclusively defined in terms of five universal physical constants, therefore, they are seen as perfectly natural units, inasmuch as they are independent from any human conceptualization. In the simple but convincing words of their inventor, these units "would necessarily retain their significance for all times and for all cultures including extra-terrestrial and non-human ones and therefore deserve the term natural units".

D'Arcy Thompson (1860)

The education of D'Arcy Thompson was characterized by the simultaneous study of mathematics and biology: this formation made him the first mathematical biologist. What prompted his studies was the belief that Charles Darwin's theory did not provide the ultimate and final explanation of evolution. While recognizing an important role for mutation and selection, Thompson considered them as subordinate to the intrinsic and permanent rules of biological growth and forms that seem to somehow provide harmony and meaning. Under this alternative view, a purely functional concept (which is exclusively focused on the relationship between the structure and its goal) was developed and analyzed in depth. In his notable work "On Growth and Form", Thomson maintained that nature's role is "limited" to displaying a reflection of the forms conceived in geometry. The forms and growth processes of all living beings tend to follow the same general patterns, and this phenomenon does not result from their relatedness, but rather from the fact that they apply common geometrical and semantic rules: in turn, these combine among themselves, thereby reaching a higher degree of complexity. It appears that somehow a substantial portion of reality indeed exhibits the tendency to develop on the basis of few principles and that the differences both between individuals and between species can be described through simple mathematical transformations.

Rabindranath Tagore (1861)

He is regarded as one of the fathers of twentieth-century Indian culture. His work as a philosopher, poet, musician and playwright represented one of the first significant attempts to unite the Eastern culture, into which he was born, and the Western culture that he came to know very well thanks to his studies in England and his numerous journeys. He supported India's liberation struggle by the side of his fraternal friend Mohandas Gandhi. The fundamental themes that can be found throughout his lyrical composition are linked to a profound religious inspiration resulting into a pantheistic view of the universe according to which every single thing is indissolubly connected with the totality: this is what made the poet be in love with every form of life, nature and humanity, without ethnic or sexual distinction. Each Tagore's composition is underlain by some of the most characteristic concepts of his culture, such as the exhortation to all men to look for the sense of life in the harmonic reconciliation and reunification with the universe and the conception of happiness as the key to make each and every moment immortal. Tagore was the first non-Westerner to be awarded the Nobel Prize.

David Hilbert (1862)

David Hilbert not only was one of the most talented mathematicians of his generation, his approach to mathematical research marked the whole work in the first decades of last century and provided us with cues and perspectives that are still fertile today. Hilbert himself would have probably appreciated a summary of his life in a few, simple statements; he was born and raised in Konigsberg (the same city of Immanuel Kant) and it was at the University of Konigsberg that he received his doctorate and he cultivated crucial relationships for his work (most importantly that with Hermann Minkowski), in 1895 he moved to Göttingen, where he taught until his death. His first mathematical contribution was in the branch of algebra: he formulated a method to demonstrate the so-called "finiteness theorem" whose nature was so revolutionary that the editor of the *Mathematische Annalen* rejected the article asserting: "this is Theology, not Mathematics!". Later, he recognized that "even Theology has its merits". However, the field in which he became well-known is that of formal systems: in 1899, with the text "Grundlagen der Geometrie", Hilbert replaced the old Euclidean system with a new formal system of 21 axioms. At the International congress in Paris in 1900, he made what is acknowledged as the most important discourse ever given by a mathematician to his colleagues: he presented the most significant unsolved problems to be solved as the new century dawned; among these, there are celebrated problems such as Riemann's conjecture, the last Fermat's conjecture (now Wiles' theorem) and Goldbach's conjecture. Furthermore, with this statement and some subsequent publications, Hilbert laid the foundations for a full-fledged philosophy of mathematics, namely, formalism. The underlying idea is that mathematics consists in a manipulation of formal symbols, starting from axioms whose solidity can be guaranteed, according to definite rules of derivation. The fundamental pursuit of Hilbert's program is to determine an axiomatic system from which all arithmetic truths can be derived, and whose consistency can be proved thereby placing the discipline on clear, certain, unquestionable foundations. Unfortunately, no such happy ending was possible for the history of mathematics: in 1931 Kurt Goedel demonstrated that a system containing the whole of arithmetic cannot be proved to be consistent employing rules comprehended within the system itself. Nevertheless, Hilbert's program survived in the spirit, if not the substance, in several subsequent works: without his contribution, we wouldn't have had either Goedel's theorems or everything that followed, such as contemporary recursion theory and, more generally, the development of mathematical logic as an independent discipline. Furthermore, modern proof theory, recovering from the first Hilbert's dream, produced amazing and unforeseen results: in the course of the Twentieth century, the consistency of Peano arithmetic was proved with quasi-Hilbertian methods and, more recently, it was demonstrated that practically the entirety of the mathematics applied to science can be reduced to finitist mathematics *à la Hilbert*. It was probably Minkowsky to induce Hilbert to focus also on physics: his studies on kinetic gas theory and radiation theory led him to formulate ideas close to the Einsteinian ones about the field equation within General Relativity. Finally, the invention of the space named after him, i.e. a generalization of the infinite dimensional Euclidean space, places him among the most influential mathematicians in the development of early quantum physics. His confidence in our ability of identifying the primitive bases of arithmetic and in the possibility, at least in principle, of giving an answer to every mathematical question is exemplarily "axiomatized" in the epitaph engraved on his tombstone in Göttingen: “we must know, we will know”.

Mohandas Gandhi (1869)

Gandhi, whose complete name was Mohandas Karamchand, was born into a family of high-rank officials. At the age of nineteen he moved to London to pursue his education as a lawyer; A few years after completing his studies, he was hired by an Indian firm to work as a legal consultant in South Africa. There he was brought to face the harsh discriminations inflicted on the Indian immigrants by the English, and this led him to elaborate his notable manifestations of protest. The African experience produced a profound change in him: after his return to India, he began implementing strategies of non-violent struggle including fasting as a form of political protest to persuade the English to leave India. His example soon became one of the benchmarks of the National Independence movement. The outstanding success of Gandhi’s initiatives can be truly appreciated only if one takes into account his vast understanding of the English and their conception of freedom, justice and law. It should however be emphasized that in these years his line of non-violence came to assume rather radical and controversial stands. In 1940, during the German bombing campaign in England, Gandhi addressed the English suggesting them to lay down the arms “as being useless for saving you or humanity”. And he went even further: the English should invite the Italian and the German “to take what they want of the countries you call your possessions. If these gentlemen choose to occupy your homes, you will vacate them. If they do not give you free passage out, you will allow yourself, man, woman and child, to be slaughtered, but you will refuse to owe allegiance to them”. His life was an example of perseverance and probity: he had been a vegetarian since his early age, at the age of thirty-six, although he was married, he took a vow of chastity. Gandhi was assassinated by a Hindu fanatic.

Maria Montessori (1870)

In days when women were practically precluded from receiving any university education, Maria Montessori studied at the Medical School of the University of Rome and she graduated in 1896 with a thesis in psychiatry, thereby becoming the first female doctor in Italy. It is not a case, then, that among her many social interests, she was particularly drawn to the cause of helping female emancipation (particularly famous in this regard is her speech at the Berlin Congress in 1896). Working with children affected by psychic problems, she soon became aware of the superiority of a correct educational experience over traditional medical treatment. She also graduated in philosophy and several pedagogical researches led to her greatest intuition, namely, applying the same educational methods used with disable children to normal children. In 1907 she opened the first Casa dei Bambini (i.e. Children's House) that was furnished and designed to be in harmony with the child's possibility of development and interaction with the environment and it was an instant success, most notably at an international level: Europe, Asia, America). Montessorian pedagogical thought rests on the idea of science intervening in the field of education as an essential requirement to build a rigorous and repeatable method. She identified two distinct stages in the child's development: the first one (from 0 to 3 years of age) is characterized by the unconscious absorption of environmental inputs; a second one (from 3 to 6 years of age) is marked by the logical organization of the mental contents within. All this is pervaded by a "systemic" conception of the child: on the one hand, there was the firm belief that it is only through freedom that the child can develop creativity, self-control and self-correction of errors (according to Montessori, discipline can only emerge from freedom and due to this fairly revolutionary idea, as it clearly contrasted with the one embraced by the totalitarian regimes of her time, she was forced into exile); on the other hand, it became fundamental to "educate" parents and teachers as to support the full development of the child's personality. Furthermore, inasmuch as sensory-motor development is among the primary principles of the Montessorian didactic method, a paramount importance was given to didactic material (the child is immersed into the environment and he has to learn to interact with it): the choice of the interaction object had to stem from the spontaneous interest of the child and this was the only way through which self-education and self-control, namely, essential tools for the development of individuality, could actually occur.

Bertrand Russell (1872)

Whatever the opinion one may have about the distinct scientific contributions of Bertrand Russell, there can be no difference with respect to recognizing his immense stature as an out-and-out intellectual and the unequalled influence he has exerted throughout the first half of the Twentieth century. Following the premature death of his parents, he was raised by his grandmother and he undertook his studies in mathematics at the *Trinity College*, Cambridge. His most significant contributions to mathematics are in the field of foundations and logic: Russell's paradox is as simple to state as it is profound in its consequences. Consider the set of sets that do not belong to themselves, which we denote by R: for example, the set of abstract objects will belong to this set, inasmuch as it is abstract; the set of cats will not, since it is not itself a cat, and so on. Does R belong to itself or not? It is easy to discern that R belongs to itself if and only if R does not belong to itself! With the discovery of this paradox of set theory, Russell spoilt the life of Gottlob Frege and tantalized entire generations of mathematicians and logicians. His peculiar contribution to the newborn discipline of mathematical logic at the beginning of the century was the monumental work "Principia Mathematica", written with Alfred North Whitehead and, according to a famous joke, wholly read only by "three Polish logicians". Philosophically, there exists (almost) no theory that Russell did not embrace sooner or later: he was an idealist back to the days in Cambridge, then he met Giuseppe Peano, he changed his logic and became the symbol of the reaction against Hegelism; with his work "On Denoting" (1905) he marked the birth of analytic philosophy. It is not only his works on the theory of knowledge and philosophy of language that render Russell worthy of the recognition of posterity, but we also owe him thanks for saving Ludwig Wittgenstein from a life as a mediocre engineer. As the story goes, Wittgenstein, who had just arrived at Cambridge, showed his writings to Russell, asking whether he was good enough to be a philosopher: not only Bertrand's answer was affirmative, but it didn't take long before he went from being the teacher to being the student of the genial newcomer. His non-academic life matched the eccentricity of the character: he married four times, he had innumerable mistresses and he always managed to keep up with his periodical financial troubles thanks to his divulgative books: his outstanding cleverness, expositive clarity and superior *sense of humour* gained him the Nobel Prize in literature in 1950. During the First World War he was dismissed from Cambridge and imprisoned for his pacifism, however, political commitment was a constant element of his life: during the Fifties and Sixties he became, together with his friend Albert Einstein, a point of reference for anti-nuclear protests (for which he was convicted again in 1961). Russell continued his political and social activity in defence of human rights until his death at the age of 97: the Tribunal on war crimes in Vietnam is named after him.

Carl Gustav Jung (1875)

Just like his master Sigmund Freud, Carl Jung studied medicine in Switzerland, and only later did he focus himself entirely on psychoanalysis. His relationship with Freud was initially characterized by a great admiration and a complete adherence to his views; nevertheless over the years significant divergences, on both theoretical and methodological grounds, arose between the two. Jung's work focused on the unconscious discovered by Freud, but the medical-scientific approach of the master was integrated with a "spiritual" research centred on symbols, myths and religion. The great revolution brought about by Jung consisted in his conceiving man no longer as a single unit, but as a being immersed in a community whose influence emerges since birth as something common to all of its members, namely the "collective unconscious". According to Jung, there exists some kind of innate knowledge, i.e. the archetypes, setting up as pure unconscious patterns of behaviour which are transmitted from generation to generation. Jung believed these patterns to be universal. In accordance with his personal view of the discipline, Jung thought that psychoanalysis should not confine itself only to the study of man as a patient, but rather expand its focus onto man as healthy individual to help him enhance his capabilities. In 1923 Jung began to build his "Tower", a circular building near Geneva which was enlarged and remodelled numerous times throughout the years.

John Watson (1878)

John Watson was one of the most important psychologists of the twentieth century. His studies were initially focused on the observation of animal behaviour and it was only later that he devoted himself to the analysis of human behaviour. The main conclusion he drew from these researches was that both, although with a different degree of complexity, were moved by the same fundamental principles. According to Watson, they behave like complex machines reacting to any occurrences on the basis of schemes acquired in past experiences. Watson's attempt was to lay the foundations of a psychology that was better equipped to fulfill the rigid scientific requirements of verifiability and therefore exclusively concerned with what could be observed and studied directly and scientifically, i.e. behaviour. At the age of 42 he was involved in a major sexual scandal due to his affair with a student (with whom he later married in second time), his love-letters to her were published by newspapers. He was forced to resign from his academic post, his wife obtained the divorce and considerable compensation payments that left him with financial difficulties. Subsequently, Watson put in second place innate contents and natural predispositions to focus on the study of acquired behaviours. Behaviourism obtained widespread recognition and it became the psychology of reference for some sectors of artificial intelligence and computationalism. Several elements are contiguous to the theories of Ivan Pavlov and Russian physiologists, since Watson identified conditioning as the central instrument of his psychology.

Albert Einstein (1879)

Albert Einstein is undoubtedly considered the most prominent theoretical physicist of the twentieth century and, together with Newton, one of the greatest of all times. We all associate his name and his unmistakable face with the most recognizable equation in physics, $E=mc^2$, and with his Theory of Relativity (special and general). However, Einstein also gave significant contributions to quantum mechanics (even if throughout his life he remained an opponent of orthodoxy), to statistical mechanics and to cosmology. He was born in Ulm, in Germany, into a family of Jewish origins. In his childhood, Einstein attended a Catholic school, he studied violin and he demonstrated a precocious talent for mathematics. The stories according to which Einstein had difficulties in scientific subjects can be disregarded as nothing more than urban legends, nevertheless it is an established fact that the prestigious Polytechnic Institute in Zurich rejected his first entry application, due to his insufficiency in meeting the requirements for humanistic subjects. At the Polytechnic he met and fell in love with his (future) first wife, the only woman in Europe admitted to the Swiss institute. Einstein completed his education by obtaining a doctorate while he was working at the Patent Office in Bern, it was the year 1905, i.e. the *Annus Mirabilis*. In his spare time, the young physicist wrote four papers of which three were Nobel Prize matter: on Brownian motion, the photoelectric effect and that on special relativity. These last two directly contributed to the foundation of the two theories that have been guiding physics from the beginning of the twentieth century until today: the former showed that the quantization of energy levels is a totally general phenomenon which is intrinsic of light (it was this *paper* that gave rise to the idea of photon in 1909); the latter, titled "Zur Elektrodynamik bewegter Körperc", introduced a new theory on the relationship among mass, energy and time. It would originate the so-called special theory of relativity, a veritable revolution in physics which culminated in the renowned equation between mass and energy: $E=mc^2$. In 1915 Einstein presented a new theory of gravitation to the Prussian Science Academy, the so-called general theory of relativity: this new work replaced Newton's gravity equation with Einstein's field equations; within the theory's four-dimensional world (the three of space and the one of time) gravity is no longer considered as a force instantly acting at a distance, but rather the result of space-time curvature. The theory was simply, insanely counterintuitive, but the wind was bound to change soon. In 1919, Eddington's photographs of solar eclipse provided the first, spectacular confirmation to Einstein's intuitions; on November 7, the Times came out with the title "Revolution in science – New theory of the Universe – Newtonian ideas overthrown". General relativity has been described as "the greatest accomplishment of human thought about nature" and "probably the greatest scientific discovery ever made". For the very first time in the history of science a scientist came to be famous and recognizable at a global level. In 1921 he was awarded the Nobel Prize in physics, quite oddly not for his works on relativity but for his 1905 paper on the photoelectric effect. Because of the ascent of Nazism, Einstein was forced to emigrate to the USA. He accepted a position at Princeton and in 1940 he became an American citizen. He spent his last years as a scientist, on the one hand devoting himself to the research of a further simplification of the fundamental laws of physics (which was named "*Unified Field Theory*"), and on the other, participating to the debate over the philosophical interpretation of quantum mechanics. Given the substantial exactness of the theory, how does the world have to be made in order for formalism to be satisfactorily interpreted? Throughout his life Einstein opposed the literal interpretation of the theory, as he rather considered it as an excellent, yet incomplete, approximation of the real (presumably deterministic) theory of the infinitely small.

José Ortega y Gasset (1883)

He was born into a liberal-inclined family and he studied at the Jesuit school of Miraflores; ironically, it was exactly in this period that he lost his Catholic faith. He graduated in letters and philosophy, specializing in Husserlian phenomenology and Heideggerian existentialism to devote himself to teaching. Soon philosophy came to occupy a central role also in his work as a writer, in fact he even founded the Revista de Occidente, which rapidly became one of the most notable publications in the field. He lived the years of dictatorship in Spain and in 1929 he witnessed the arrest of numerous students who had protested against the political interference in academic life; in response, Ortega y Gasset resigned from his chair and he persisted with his philosophy lectures at the Barcelò theatre in Madrid, with great public success. He was a major opponent to the dictatorial regime of his time, and throughout his life he pursued his struggle for the formation of a national party inspired by liberal socialism. Therefore, he decided to dedicate himself to the theoretical development of the movement, providing significant contributions to the advancement of remarkable social ideas of liberal inspiration. In the "Meditaciones del Quijote", Ortega explored the role of the Self in the world. According to Ortega, the one thing we are given is always and only a relationship between the Self and a circumstance; if the second term of the relation is not preserved, then also the first one vanishes. The absolute fact is the coexistence between our Self and things. In order to contrast an abusive politics permanently attempting to impose conformism, Ortega promulgated the individuality and the uniqueness of the single human being ("an organ of perception different from all others which reaches pieces of reality unknown to others like a tentacle"). However, his most meaningful and distinct work is "La Rebeliòn de las Masas", published in 1930, a text that was bound to become one of the most notable socio-political treatises ever written. Ortega addressed his criticism to the mediocre protagonist of our time: the mass-man. The mass-man cannot be identified with any specific social class, he nullifies all that is individuality; albeit he has no quality, he is satisfied with being what he is; he lacks historical memory, without which it becomes impossible to correct one's mistakes; he is a bundle of platitude and prejudice whose only will is to undermine who is superior to him and whomever he perceives as different. As he feels anonymous and almighty, the mass-man identifies himself with the omnipotence and the anonymity of the state or the group, living rise to the disastrous and dangerous forms of dictatorial and massified society.

Erwin Schroedinger (1887)

In 1926 four papers transformed the spectacular physical theory that was ascending in those years, namely, quantum mechanics. The author is Erwin Schroedinger who, starting from "Quantisierung als Eigenwertproblem", developed the differential equation that is now named after him. The famous wavefunction allows to give a description of a quantum system evolving in time and space and it marked the rise of a new formalism for quantum mechanics, which was an alternative to the approach based on matrices employed by Werner Heisenberg. Although, as he demonstrated in the fourth paper of the series, the two systems are mathematically equivalent, Schroedinger remained convinced that his equation could provide a good representation of what actually occurs in the macroscopic reality when it exhibits wavelike behaviour. Nevertheless, the literal interpretation of the function presents considerable problems: if a particle like an electron is a tiny packet of waves, the function predicts that it will spread out until it attains macroscopic dimensions! For this and other reasons, the current orthodoxy among physicists is to see it as representative of a probability density. In 1933 Schroedinger received the Nobel Prize in physics; however, the rise of nazism in Germany was a major source of concern. He planned to move to Oxford with his wife and the family of an assistant, as he held an interest for this assistant's partner with whom he had a relationship and who would also give him a daughter. However, setting up house with two women at Oxford resulted rather problematic: the unconventional life of the physicist impeded a successful inclusion; this same reason was the obstacle that prevented him from accepting a permanent position at Princeton one year later. From this stemmed the unhappy choice of returning to Austria, at Graz in 1936: in fact, the nazi regime had not overlooked Schroedinger's hostility and it would, unsuccessfully, try to restrain him from leaving the country; for 17 years since 1940 he remained at the *Institute for Advanced Studies* in Dublin. Most people associate Schroedinger with the famous and unfortunate cat of the homonym thought experiment that was illustrated in an article in which the paradoxical behaviour of quantum systems is transferred to macro-systems as the cat and the box containing it; Schroedinger's paradox represented an original contribution to the ongoing debate over the foundations of quantum mechanics, in the same year (1935) of the publication of the polemical article on the EPR paradox. In 1944, in "What is Life?", Schroedinger visionarily discussed the possibility of storing genetic information within molecule: both Francis Crick and James Watson recognized in their respective autobiographies that the intuitions of the Austrian physicist played a prominent role in their discovery of DNA. For his whole life Schroedinger was fond of Hinduism and he concluded his book leaving open the possibility that each individual's knowledge is but a part of a greater collective consciousness pervading the universe.

Norbert Wiener (1894)

"Dark hero of the information age" is the well-suited title of a recent biography of Norbert Wiener: the term "hero" emphasizes how crucial a role he played within the scientific development of the twentieth century, while "dark" underlines that such importance is known only by relatively few people. The extremely rigid education imparted by his father, who was a professor of Slavic languages at Harvard University, coupled with his exceptional natural skills made the infant Norbert a child prodigy: at the age of eleven he enrolled at *Tufts University* and he completed the program of studies for mathematics in only three years. At eighteen he was awarded a doctorate from Harvard University for a thesis on mathematical logic, just before travelling to Europe to continue his studies: at Cambridge he worked, among the others, with Bertrand Russell, while in Göttingen he studied mathematics (with David Hilbert) and philosophy. At the age of 24 he joined MIT as an instructor of mathematics, and there he would spend the remainder of his scientific career: throughout his life, almost at odds with his inclination for the practical application of theoretical science, he remained the paradigm of the genius professor with his head in the clouds. According to a famous anecdote, on his way back from the university, Wiener, unable to remember the address of the house he had just moved to, decided to go to the old one, hoping his wife would come looking for him! His first scientifically significant attainment was a mathematical model of Brownian motion: his approach resulted so extremely general that it turned out to be a decisive factor for the growth of probability theory and the birth of the theory of stochastic processes. Nonetheless, the most significant mathematical contribution was arguably his work aimed at solving the practical problem of processing electrical signals. Joseph Fourier had already showed how to decompose a periodic signal into a sum of sinusoids; but some signals, including the electrical ones, diverge from Fourier series: Wiener provided a solution to the problem through what he himself named as "generalized harmonic analysis". His interest in the application of theoretical studies constituted the sound foundation upon which he would construct "cybernetics"; in "Cybernetics or Control and Communication in the Animal and the Machine" he introduced and developed a new scientific discipline concerned with the study of the communication and control systems that enable living beings, machines and organizations to successfully perform their functions. At the core there is the notable concept of *feedback*, namely a system's capability to use part of its outputs as new inputs for subsequent computations, thereby dynamically controlling its own behaviour. Less known, but perhaps more interesting, is his book "The Human Use of Human Being" in which he anticipated nearly all the issues related to the budding information society, from the language to educational systems, from the concept of information content to that of entropy.

Jean Piaget (1896)

Jean Piaget's curriculum is unquestionably an exceptional one. He was professor of Psychology at the University of Geneva and at the Sorbonne, director of the Institute of Education Sciences, director of the International Bureau of Education, the founder of the Center of Genetic Epistemology, as well as the first European to receive the American *Distinguished Scientific Contribution Award* for his revolutionary perspective on the nature of human knowledge and intelligence. He was extraordinarily prolific: we are referring to more than forty books, together with a number of articles, only on the psychology of the child, which exceeds a hundred, besides his contributions to philosophy, science and education. Equally outstanding is his precociousness: his first publication was a paper about an albino sparrow which he wrote at the age of ten; he was unable to carry out his first job at the Museum of Natural History of Geneva (in the mollusca section), as he hadn't completed his secondary education; at only twenty he published his first philosophical paper on the relation between the parts and the whole and the logical organization of actions; at the age of twenty-one he graduated in Natural Sciences.. The field of study where Piaget left the most indelible mark is obviously developmental psychology. Firstly, he demonstrated that the thought of children and that of adults are qualitatively different; subsequently, he stressed that the concept of intelligence seems to be strictly related to the ability to adapt to the external environment. The fundamental point of his discovery lies in his recognition that action and behaviour play an essential role in the formation and the development of human cognitive abilities: there exists an assimilation process (whereby an object or an event are incorporated into a cognitive schema already present) and an accommodation process (which consists instead in the modification of the cognitive structure through the addition of new objects previously unknown). Both processes are used alternatively in a self-referential way, in a constant search for a sort of psycho-physical equilibrium (called "fluctuating equilibrium"). From these theoretical foundations stemmed the attempt (and a successful one) to instruct a new class of educators capable of identifying the optimal conditions for learning and the underlying psychological dynamics, with the intent to sustain the development of intelligence and action in children.

Maurits Cornelis Escher (1898)

Although he is considered one of the leading figures of that form of art commonly referred to as "rational art", during his lifetime, Maurits Escher was never an instant success nor did he achieve any considerable artistic recognition. In fact, this was the collegial judgement of the art school he attended: "he is too tight, too literary-philosophical, a young man too lacking in caprice, too little an artist". Besides his deep fondness of Italian landscapes, his mind was persistently attracted by a type of "mathematical" representation of reality. Arguably, this explains why physicists and mathematicians were driven to appreciate the originality of his work, well in advance with respect to art critics. Escher referred to himself as literally obsessed with symmetries, continuity, infinity and most of all with the three-dimensional reproduction of two-dimensional surfaces: when he was painting “he played a game, satisfied his whims with mental images with no other goal than to investigate the possibility of representation itself”. The power of his works lies in the mind-blowing effect of self-reference: for instance, in “Print Gallery”, a man is looking at a painting depicting a city that contains a gallery with the man observing the painting enclosed therein! It is representation that describes itself. By dealing with the issue of infinity, Escher focused on the regular and cyclical division of the plane: besides producing several works on this theme, he even wrote a rather technical treatise. Furthermore, his analysis was oriented to the subject of perspective, where Escher emphasized the foremost importance of the phenomenon of relativity. The stairs are undoubtedly Escher’s most distinctive figurative element: they are the unchallenged protagonists of his drawings, the artist, believed them to be the most suitable to the attempt of expressing the continuity of infinity. Escher’s ingeniousness exactly resides in his capability to make highly abstract paradoxes and problems “visible”.

René Magritte (1898)

Although he is considered one of the most original European representative of the entire Surrealist movement, Magritte didn’t completely assimilate all of its typical features. In fact, as opposed to his colleagues, Magritte was not particularly interested in undisguising human unconscious in its countless forms: rather, his aspiration was to disclose the mysterious facets of the universe, to uncover and describe its ultimate laws. The first part of his artistic production is strictly related to his past: the works in which faces are covered with a white sheet seem to have reference to the shock the painter experienced at the age of thirteen when Magritte saw the body of his suicide mother be retrieved from a river with a cloth pulled over her head. Later, he diversified his experimentations, thereby undertaking an in-depth exploration of the specific possibilities of the different expressive and perceptual levels. Magritte masterly played with the permutation of sense, using both unusual combinations and unreal deformations. He was particularly effective in conveying the distance that separates reality from representation, a distance which sometimes shrinks so much as to cancel out, just like in the self-referential realities that represent themselves; we may even argue that the peculiarity of his surrealism actually stems from the reasoned "confusion" operating between these dimensions. In one of his most recognizable works, "Ceci n'est pas une pipe", the perfect reproduction of a pipe is accompanied by the words "this is not a pipe" written below it: this apparent contradiction can be decoded as soon as we bring ourselves out of the reference system in which the author seemingly wanted to place us into. The painted pipe is not really a pipe because it is exactly just a picture, i.e. the result of a representation. In a quote of Magritte himself we can grasp the meaning and the purpose of his art: to help us "hear the silence of the world".

Walt Disney (1901)

From the standpoint of the Game, Walt Disney is definitely one of the figures that enabled us to undertake the venture with greater pleasantness. If it is true that one of the fundamental values we need to be as happy as possible is amusement, we cannot but give Walt sincere "thanks". Walt Disney was a great analogical player: director, narrator, producer, dubber, animator, cartoonist, as well as obviously the creator of most of the characters that still today charm adults and children. His passion for steam trains led him to invent the cartoon par excellence (which Walt Disney saw as his alter ego), namely Mickey Mouse. The use of ever new technological systems, as, for instance, the *live action*, enabled him to elegantly render the not-always-clashing contrast between reality and fantasy, a contrast that finds in him a superb balance. He did not content himself with ushering us into a dream world in the narrow space of our home and in movie-theatres, Walt Disney created what can only be defined as an entrepreneurial empire epitomized by the famous theme parks that were constructed all over the world, where his project of unifying fantasy and reality in some way (perhaps the only possible one)finds its three-dimensional accomplishment.

Werner Heisenberg (1901)

Oddly, some of the chief discoveries of the twentieth century bear names that are not really encouraging for the endeavour of knowledge: what deserves a prominent spot next to Goedel's "incompleteness" and Einstein's "relativity" is undoubtedly Heisenberg's "uncertainty". Heisenberg was born at Würzburg on 5 December 1901, on the same day as Walt Disney. The young Werner made his first steps in mathematics and physics at the *Maximilians Gymnasium* in Munich; he took part to a competition for Bavarian secondary-school students, where he was assigned an award for his excellence in scientific subjects, which compensated for a far less impressive preparation in humanistic studies. After risking his life due to typhus, Heisenberg came to university: since he was drawn to pure mathematics and number theory, thanks to his father's intervention, he obtained an interview with the famous mathematician Ferdinand von Lindemann. Nevertheless, such interview failed to provide the young talent with the answers he was looking for: disappointed, he enrolled at the faculty of theoretical physics, where he was gladly received by Arnold Sommerfeld. He completed his doctorate studies in 1923, short after his first encounter with Niels Bohr at Göttingen. In 1924, during a visit to Copenhagen, he also met Albert Einstein. His relationship with Bohr was bound to mark a new era for physics: as Heisenberg later recognized, "I learned optimism from Sommerfeld, mathematics at Göttingen, and physics from Bohr". In 1925, it became crystal clear to what an extent Heisenberg had learnt physics, in fact in that year he was already able to produce an original and foundational work: his matrix mechanics is the first formalization of the rising quantum mechanics. In 1932, he was awarded the Nobel Prize for his major contribution to theoretical physics. In 1927, he developed the uncertainty principle, which made him widely known: it states that for certain pairs of observable physical quantities of a single particle, if the accuracy of the measurement of one quantity is increased, then the uncertainty of the simultaneous measurement of the other one increases as well; this effect is most astonishing for the pair formed by the position and the momentum of a particle. The rise to power of Nazism in Germany marked the beginning of a period of disorientation and controversy in the life of the physicist. At first, his succession to Sommerfeld's chair in Munich was stopped by the regime: even though he wasn't Jewish, Heisemberg was labelled as "*White Jew*" because he taught Albert Einstein's relativity theories. During World War II he worked with other German physicists on the atomic bomb development, however, what role he played in the matter is unclear. On the one hand, some maintain that Heisenberg, due to moral scruples, willingly opposed the project, trying to hamper its development; on the other, there are reasons to believe that it was a trivial miscalculation of the bomb's critical mass to dissuade Germany from investing in atomic weapon research. From 1946 until his retirement, Heisenberg held the position of director of the Max Planck Institute for Physics and Astrophysics, first at Göttingen and then at Munich. He died in 1976. His epitaph reads: "*Er liegt irgendwo hier*", that is "He lies somewhere here".

Alfred Tarski (1902)

Alfred Tarski, together with Kurt Goedel, played the most crucial role in shaping modern logic. Alfred Teitelbaum – this is the name he was born with – was native of Warsaw; soon after he began his studies in biology, his professors, who had been very impressed by his talent, convinced him to become a mathematician. At the age of 19, he wrote his first work on set theory; while at 22, he published a paper on what is now known as Banach-Tarski paradox: a sphere can be partioned into a finite number of pieces and then reassembled into a bigger sphere or, alternatively, into two spheres, each of the same size as the original sphere! In the early 1920s, he changed both religion, by converting to Catholicism, and name, by becoming Alfred Tarski: presumably, this choice was affected by the nationalist, anti-Semitic climate in the Poland of the time. He matured at the great Polish school of logic that gave rise, among other things, to the "Polish notation", i.e. a notational method for mathematical logic which doesn't need parentheses. The field of his researches was remarkably vast: during his studies he dealt with topology, geometry, algebra, and several branches of mathematics. The works that drive logicians to venerate him (and that philosophers should read) are certainly his 1930s researches concerning the notion of truth: it was in those years that he developed a rigorous definition of truth for formal languages, he founded model theory and used it to specify the relation of logical consequence between propositions, namely, he stipulated the conditions under which the conclusion of an argument, given the truth of its premises, cannot but be true,. Furthermore, he demonstrated, along lines of reasoning similar to those employed for the Goedelian discoveries, that it is impossible to define the truth predicate of a language within the language itself; in fact, if we had such predicate, we would be able to construct in our language a proposition that states its own falsehood: but this obviously takes us back to the famous Liar Paradox, i.e. "this sentence is false". In order to escape this paradox, we must abandon the claim to define truth for a language within itself, and content ourselves with accepting the distinction between language and meta-language.

Karl Popper (1902)

Karl Popper studied metaphysics and physics, and he received his degree in philosophy in 1928. In the course of his career he came to deal with practically all the aspects of reality. The first problem he concerned himself with was that of demarcation: how to distinguish science from pseudoscience. His answer rests on the notion of falsifiability: only scientific theories can, in principle, be refuted by facts. In other words, Popper remarked that, in order to ascertain its validity, the empirical verifiability of an hypothesis is not sufficient, what is necessary is the possibility of empirically verifying also its content. This intuition allowed science to make a huge qualitative leap. Later, he addressed the issue of induction: how can I go from the observation of one hundred red apples to the conclusion that all apples are so? Popper's response is very simple: there is no possible way to work such magic, since induction is not logically justifiable. His work concerning politics and society is particularly conspicuous and thought-provoking. He was a firm opponent of any form of totalitarianism and one of the greatest proponents of liberty, he harshly criticized the view of historicists, according to which the development of society is governed by inescapable and necessary laws to which, obviously, it is impossible to oppose. According to Popper, all this would inevitably lead to a political and social rigidity of the state, often resulting in forms of totalitarianism and authoritarianism against which he fervently advanced an alternative proposal. This new type of society is called "open", for it is constantly exposed to any intervention and correction aimed at its ongoing refinement (it is fairly clear that in such a form of society there do not exist any "necessary" laws whose validity is, a priori, guaranteed). Within this system, it would be possible to encourage criticism rather than oppress it, thereby enabling all of its members to actively take part to the decisions that affect the community and giving the governed the opportunity to replace governors if their action resulted unsatisfactory (this constitutes the ultimate essence of "rational" democracy). Succinctly, Popper contrasted a closed, totalitarian and paternalistic society with an open, liberal and responsible one where we have a necessary and positive competition among its members to achieve a higher status. As a consequence, any form of movement advocating intolerance, and therefore averse to listening to rational arguments, must necessarily be banned from society ("the right not to tolerate the intolerant"), equivalently to the incitement to murder and slavery. Karl Popper was a revolutionary figure endowed with a prolific comprehensiveness, and he can certainly be numbered among the greatest players of the twentieth century.

Alonzo Church (1903)

Alonzo Church is one of the fathers of computability theory, namely, the discipline that can be considered as the mathematical-theoretical foundation of computer science. He studied at Princeton, a context that, in the Thirties, was offering hospitality to at least three other "great players": Alan Turing, John von Neumann and Kurt Goedel. Two of his very well-known contributions exactly date back to the end of the Thirties: the Church's Theorem and the Church's Thesis. The former establishes the undecidability of first-order logic, that is to say, it shows that there does not exist an algorithm that decides, for each formula, whether it is a logical truth or not. The Church's Thesis instead demonstrates that the functions that are computable by an algorithm are all and only general recursive functions; in other words, not all the problems can be mechanically solved. The publication of Church's works is slightly antecedent to that of Turing, however, as Church himself recognized, the formulation by the young English scientist is far more intuitive and engaging (indeed, Turing then moved to Princeton to complete his Ph.D. under the supervision of Church). The combination of the studies by Church and those by Turing led to the Church-Turing thesis: the computable functions are all and only those computable by a Turing machine. In fact, it can be demonstrated that Turing machines compute all and only the general recursive functions and, therefore, that the ideas of Church and Turing are perfectly consonant with each other. The importance and originality of his proposals gained him a well-deserved distinct place not only in the last century's history of logic: the lambda calculus, i.e. the mathematical notation he invented and employed in computability theory, is the grandfather of functional programming languages such as LISP, for instance, which made the history of computer science and artificial intelligence.

John von Neumann (1903)

Until the Nineteenth century it was not difficult to encounter personalities whose contributions extended to the most different fields of scientific knowledge, whereas in the Twentieth century, in light of the progressive specialization of each discipline, the situation changed dramatically. Nevertheless, it is certain that one of the most eclectic figures of science in the Twentieth century is John von Neumann. János, this was his given name, was born in Budapest in 1903. There are countless stories about his prodigious intelligence: at the age of six, he could mentally divide 8-digit numbers, learn by heart pages of the telephone directory and speak Ancient Greek; before he was ten, he had read a 44-volume historical encyclopaedia, studied analysis and mastered 4 foreign languages; at 12, in mathematics he achieved a level comparable to that of a doctoral candidate and he had the curious habit of taking two books with himself when he went to the bathroom for fear of being left with nothing to read. At the age of 23, after simultaneously attending the University of Budapest, the University of Berlin, and the ETH of Zurich, he found himself with a degree in chemical engineering and a doctorate in mathematics. The first spectacular contributions were made in logic and quantum mechanics: in his doctoral dissertation he proposed a system of axioms to establish the foundations of set theory, within which there exist specific sets that cannot be a member of other sets (thereby escaping the Russell's paradox). In the Twenties the only physical theory not yet axiomatized is quantum mechanics that, at the time, suffered "philosophical" crises of foundations and it lacked a sound mathematical formulation besides the "heuristic" ones by Werner Heisenberg and Erwin Schroedinger. Between the year 1926 and the year 1932, von Neumann advanced his solution to this problem. In the Thirties, he first visited Princeton, where he would moved for good in 1933 (four years later he became an American citizen). He continued to be a leading figure in the most disparate fields: in the Thirties, he provided economics with game theory, namely a set of mathematical tools to abstractly capture competition situations among different players. His work in this domain reached its zenith in 1944 with the publication of "The Theory of Games and Economic Behaviour", a book of momentous import, written with Oskar Morgenstern. He was equally out of the ordinary also in his personal life: though he used to always wear a suit and tie (even in the Grand Canyon!) he was fond of luxurious parties, fast cars, women's legs and boozing; he proposed to his wife-to-be with the outstanding words: "You and I might have some fun together, seeing as how we both like to drink". Consistently with his long-lasting interest in the practical application of mathematics, he took part to many projects in collaboration with the U.S. army. Obviously, the most famous one is the Manhattan Project aimed at developing the atomic bomb. At Los Alamos, a triangular challenge arose when it came to complex calculations, the players being Richard Feynman, with his mechanical calculator, Enrico Fermi, with a piece of paper, and John von Neumann, with his mind. In 1944, von Neumann came to know the studies on the electronic calculator ENIAC, and in two weeks he transformed the original project as to make the internal memorization of data possible. Programmable (in the modern meaning of the word) computers are a product of his genius intuition of treating data and programs in the same way, thereby constructing programs that easily manipulate other programs. And more than this: our PCs are built according to the so-called "von Neumann architecture", which was formulated and refined in a series of works of the period between the end of the Forties and the early Fifties, which are among the major landmarks of computer science. He precociously died of bone cancer, seemingly due to radiation exposure during the Bikini atomic tests in 1946, whose safety he had firmly defended. Even the most excellent minds, at times, can make mistakes.

Gregory Bateson (1904)

Gregory Bateson dealt with a remarkable range of realms: sociology, anthropology, psychology and cybernetics. As far as the domain of psychotherapy is concerned, his main contribution lies in being the "inspirer" of several new schools, from the *Interactional School* to the Palo Alto School. His most compelling discovery is the double bind theory: this describes the situation in which, given an emotionally relevant tie between two individuals, in their reciprocal communication there would subsist an incongruity between the level of what is explicitly said and the further meta-communication level (i.e.

the intonation, the gestures, the attitudes, etc…). This situation causes the recipient to be unable to decide which of the two (often conflicting) communication levels can be deemed reliable; Bateson conjectured that the formation and persistence of this double-bind may be included among the possible sources of schizophrenia. Another interesting cue is the connection between ecology and psychology: both share the aim of creating a perspective in which the human experience may be embedded in the totality of the real. According to the scientist, there exists a strong relation between the environment and the human mind (note that, in the view of Bateson, the mind cannot be considered disjointedly from the real, as the former is part of the latter): human intelligence is able to produce profound changes in nature which in turn has determined the conditions that enabled cognitive activity to come to its full development. In a similar vein as Humberto Maturana in biology, Bateson made the foundations of his theory rest on the idea that everything depends on the observer. Therefore, there is an irreparable multiplicity of points of view, one for each system: an observer's description is always an observation of the relationship between the modifications occurring within it, in relation to another system (be it another system man, animal, or the environment); it follows that adaptation will be a more or less advanced form of compatibility between the reference system and the structure that is external to it, namely the environment. And, consistently, on the usual grounds of the power of self-reference, Bateson concluded maintaining that each system would possess the intrinsic property of being able to build and rebuild itself on the basis of its relations and interactions with the others.

Salvator Dalì (1904)

Since his adolescence Dalì had displayed a superior painting technique, he attended the School of Fine Arts in Madrid, but he was expelled from it over indignity (after being suspended twice for bad behaviour, he was chased away for good due to his calling the examining commission "incompetent"). Traditional artists did not look favourably at his creative genius, but luckily he had the chance to draw on the Surrealist movement to conform to the budding artistic models: this movement upholds the search for a form of superior reality (a "surreality"), in which the two fundamental moments of human thought, namely wake and dream, intertwine. Once he propelled himself beyond the constraining boundaries of the pure rationality of representations, Salvador Dalì succeeded in making the whole content of his unconscious emerge in his works. In his paintings, pulses and desires surface in a sort of hyperrealistic hallucinations. A few years later, it was his artistic independence and his averseness to conformity that pushed him to detach himself from the movement in which he completed his formation: for Dalì, this solely meant greater freedom to pursue his visionary attitudes. The method he employed (and for which he was harshly criticized) was defined "paranoiac-critical method". According to the artist, paranoia would be a chronic mental illness arising from systematic delusions. These disappointments, if weighted with a certain emotional charge, can flow into delusions of persecution or grandeur (Dalì "enjoyed" both and for this reason he considered himself a visionary genius). The critical part of the method instead consisted in the process of rationalization of the paranoia, the rational elaboration of its consequences. In this manner, his obscure obsessions moved from his unconscious to pictorial representation. In other words, Dalì's entire career appears as a raising of consciousness of his psychic problems that for Dalì were both the justification for his visions and the nourishment for his paintings.

Kurt Goedel (1906)

At the advent of the new millennium, Time magazine has chosen Kurt Goedel as the most important mathematician of the twentieth century. It seems that John von Neumann came to point at him as the greatest logician of all times after Aristotle (who was the inventor of logic). No less than Albert Einstein once confessed to Oskar Morgenstern that he had become member at the *Institute for Advanced Studies* "only to have the privilege to walk with Goedel on his way home". If it is fair to say that the great Austrian mathematician is not as well-known to the public at large as other figures of science of the last century, it is equally true that the veneration he enjoys among logicians goes unparalleled. Goedel began his academic career with the intention to study physics, and it was only at the second year of university that he directed his interests towards logic. In the lapse of few years (before he turned thirty-five) Goedel attained outstanding results. In 1929, his doctoral dissertation established the completeness of first-order logic; in 1940 he demonstrated that the axiom of choice does not generate contradictions when it is added to the other axioms of set theory. In 1931, in the article "Über formal unentscheidbare Sätze der Principia Mathematica und verwandter Systeme", Goedel proved that in any formal system powerful enough to express arithmetic there exist propositions that are true and cannot be proven or disproven; the method employed to achieve this conclusion builds on a self-referential approach: within the system we can speak of the system itself, in a manner not dissimilar to what we do when we allow statements to speak of themselves. In both cases, it is not difficult to come to paradoxical and unexpected results: take as example the classical "this statement is false". The theorem, which is termed incompleteness theorem, called a halt to around a hundred years marked by the attempts to establish what were the right axioms upon which the entire mathematics might have been founded; its real implications in logic, computer science, complexity theory, philosophy, artificial intelligence are still today object of investigation. More than demonstrating a theorem, Goedel opened a Pandora's box of unsuspected and mysterious connections. The European political situation of the thirties and the ascent of Nazism forced the great logician to come to terms also with reality; in 1938, he married Adele, a night-club dancer who was six years older than him. In 1940, he moved to Princeton for good, where he made friends with Einstein. In 1948, he maintained in front of the officer charged with the duty of conferring U.S. citizenship on him that the U.S. Constitution contained an inconsistency; nevertheless, he became a U.S citizen thanks to Einstein's mediation. Besides concentrating on purely mathematical works, at Princeton he studied a new argument to demonstrate God's existence (that was posthumously published) and, renewing his early passion for theoretical physics, the possibility of non-conventional forms of space-time within General Relativity, ring-shaped worlds where, after covering a certain distance, a person can be returned to the exact same space-time point from which she had started! Throughout his whole life, he suffered from periodical depressive bouts and other psychic problems; among other things, he convinced himself to eat only food cooked by his wife due to his fear of being poisoned. In 1977, when Adele, due to her own health problems, was no longer able to take care of him, he abstained from food and he came to weigh 35 kilograms; if the transmigration of souls, in favour of which Goedel had argued in life, turned out to not exist, then the most astounding logician of all times left us for good on January 14, 1978.

Willard Van Orman Quine (1908)

Willard Van Orman Quine, known as Van to friends, was one of the most influential philosophers of the Twentieth century. He was a provocative and original thinker, scientistic and an iconoclast par excellence, his arguments pose a continuous challenge to the orthodox and common-sense views in metaphysics, logic, philosophy of language and a lot more. Quine developed a precocious interest in natural sciences, almost immediately coupled with the passion for philosophical reflections; it was this attitude that led him to undertake the study of mathematics and philosophy of mathematics in the years of university, the same years in which, upon first encountering the works of Bertrand Russell, he deepened and refined his philosophical taste. After completing his Ph.d in just two years, Quine travelled to Europe for a journey plentiful of meetings and novelties; in 1932, he came into contact with the Vienna Circle, Alfred Tarski, Kurt Goedel and Rudolf Carnap. Back to Harvard, he began to publish his first works in logic; in particular, in 1937, he published "New Foundations for Mathematical Logic", in which he proposed a new set of axioms for set theory, specifically a non-orthodox system involving the presence of a system universe. There is so much Quine in contemporary thought that condensing it all in a few lines is hard task : the inscrutability of reference, his rejection of the distinction between analytical and synthetic statements, his criticism of modal logic, the universe that expands itself equally along the space dimension and the time dimension. By means of a suggestive example, Quine described the endeavour of knowledge as a boat journey: the only thing we can do to repair and improve the boat is to stay afloat on it and work with what we find on board. There does not exist such thing as "cosmic exile", a vision as privileged thinker which, insulated from scientific-cognitive progress, may help it to advance. Quine also rejected the idea that things possess essential properties and that they persist in time independently of the ordering action exercised by our cognitive acts. Therefore, it shouldn't come as a surprise that our model of the fundamental level of physical universe, with its cells and the lack of metaphysical distinctions between the different regions, may well be considered as an eloquent illustration of some of his most characteristic and influential theses. Throughout the course of his life, the philosophical genius of Quine received significant consideration and a corresponding amount of public recognitions by the scientific-philosophical community: 18 academic degrees and even a verb, i.e. "to quine", which Daniel Dennett dedicated to him. All his books were written on a 1927 typewriter, modified to introduce logic symbols in place of other characters such as "? " and "! ". When he was asked how he did without the question mark, he candidly replied: "Well, you see, I deal in certainties".

Konrad Zuse (1910)

The Charles Babbage's counterpart in the Twentieth century was a civil engineer. Konrad Zuse, as Babbage did years before, already in the course of his studies, became aware of the extent to which human life could be improved with the introduction of a device capable of performing a vast amount of computations in a quick and reliable manner. Zuse worked with the greatest autonomy, without either public funds or any correspondence with other pioneers in the sector (and, most strikingly, without ever even hearing of Babbage's machines!) and, in 1938, it was in his parents' living room that he built the Z1, a mechanical calculator. The memory of the computer was realized with metal plates; the computation system was binary and the computer also offered the possibility to be programmed. This kind of architecture, characterized by the neat distinction between computation and memory, was a forerunner of that of John von Neumann, which became standard only in the Fifties. The Z1 was followed by increasingly sophisticated models: using relays instead of plates the Z3, which was completed in 1941, was a binary calculator supporting cycle programmability (i.e. with *loops*), but not yet conditional instructions (*if… then…*). Decades later, it was demonstrated that the Z3, as primitive as it could be, represented the first approximate physical realization of a Turing machine. The Z3 was destroyed at the end of the war by an Allied bombing raid, but the almost completed Z4 was saved. By then, the ship of Reich was adrift, and Zuse and his team managed to decompose it and move it to Bavaria, where the news of surrender was received. The world was not ready for the Z4: closed in a basement, the only computer in Europe was ignored during the advancement of the Allies. For the sake of exactness, the world was not always ready for Zuse in general: in fact, another epochal idea of his, the Plankalkul, the first high-level programming language, faced a similar fortune. It was completed between 1941 and 1945, but only thirty years later was it published due to the indifference of institutions and academies. At the end of the war, he entered the world of business: in 1949, he founded the Zuse KG, through which he sold the Z4 to the ETH of Zurich; this was the first sale of computers in history. In 1967, due to financial difficulties, the company was made over to Siemens: however, Zuse had the time to invent the Z22, namely, the first computer with magnetic storage. The imaginative and ingenious engineer died on December 18, 1995 at the age of eighty-five. The scientific and technological world, in a similar fashion as with Babbage, confers one of its most prominent visionaries with a significant reward: as the difference engine that was built in London some years ago, also the Z1 received a late, but fully deserved recognition. In 1989, with 30.000 components, four persons, among which Zuse himself, managed to exactly rebuild the first modern computer.

Marshall McLuhan (1911)

As testified by his doctoral dissertation, McLuhan started from the historical study of the so-called verbal arts (grammar, logic, dialectic and rhetoric) to become one of the first researchers ever to maintain that the technologies having the most impetuous impact on our life are those related to communication; McLuhan analysed the effects of such technologies on both society and the single individual in a way that can only be described as prophetic. It seems that throughout his life, he was fond of communicating with brief and sharp sentences, capable of arousing a profound interest: proposition that initially seem immediate only to reveal themselves as very complex and stratified after a more accurate analysis. In McLuhan's conception, the secret of all communication lies in possessing the ability to pose the appropriate questions as to obtain the right answers. The media are McLuhan's true obsession, a sort of specific and autonomous environment that interposes itself between the human beings and the world surrounding them. In a slogan, the extent of the impact of communication can be concisely expressed with his aphorism: "*medium is message*". By now our world is for the most part constituted of what Plato called *technè*, the *medium*, i.e. the technological instrument of communication; being it the point of contact between us and reality, the medium necessarily cannot but produce pervading effects on society, regardless of the content it conveys; inevitably, the mental structure and the culture of a given society will profoundly be influenced by the type of technology employed for communication. In essence, the *medium* can communicate something first and foremost because it refers to its own existence: it is intrinsically self-referential.

Heinz von Foerster (1911)

Heinz von Foerster constantly opted for an encompassing vision of the real. In his studies he covered a wide range of fields from physics and philosophy to cybernetics. Among his, so to speak, "secondary" interests were *computer music* and illusionism. He was almost fifty when he founded the famous *Biological Computer Laboratory*, with the purpose of investigating the common grounds among cybernetic systems, biology and electronics. His gnoseological reflection rested on the underlying question of how the knowledge of the world surrounding us might be actually possible. In other words, does external reality exist independently of the subject experiencing it? On the basis of Jean Piaget's thought, the close correlation between action and perception became the starting point for Von Foerster's research to arrive at the view that it is our action of knowledge to construct the objects of the world. With regard to this, his considerations on chance and necessity are particularly interesting: such phenomena would not belong to nature, but they would rather simply reflect our abilities or inabilities (the concept of necessity would arise from the ability to formulate infallible deductions, whereas chance would derive from the inability to make such deductions). Von Foerster skilfully made use of the "philosophical" novelties characterizing the scientific world of his time (for instance, the theories on autopoiesis and the self-organization of biological systems, which were introduced by Humberto Maturana), with the aim of constructing a new theory of knowledge actually capable of taking the phenomenon of self-reference into account. From this arose the so-called "cybernetics of observing systems": this type of cybernetic machines operate by progressively building representations that depend on the outcome of the previous interactions with the world. In this manner, the concept of objectivity of reality tends to fade, inasmuch as what exists for the system is structurally dependent on the perceptual and cognitive activities of the system itself. Therefore, knowledge is reduced to a series of connections internal to the system between the different perception that we come to experience; it follows that truth appears as something carrying strong subjective connotations. Eliminating the absolute character of truth, we nevertheless have an important ethical imperative: each system is under the obligation to respect the others' views and to act as to produce new "perception possibilities" for itself and the other systems.

Wernher von Braun (1912)

Wernher von Braun was born the first time in Wirsitz, then Prussia, in 1912, and he died the first time in the spring of 1945, near a German village called Peenemunde. His first life is the story of a boy who dreamt of space travel and ended up becoming an SS major and director of the V2 rocket project. The second time, Von Braun was born and died in the United States. His second life is the story of the genius who contributed more than anyone else to the "conquest of space", of the independent scientist who left N.A.S.A. because of diverging visions, of the sick man who attempted to make the public opinion aware of the dangers arising from the development of space weapons. But let us proceed with order. The life of the young and negligent student Wernher von Braun changed after he came to read a tiny book called "Die Rakete zu den Planetenräumen"("The rocket into interplanetary space"). This reading was a veritable brainwave for him: suddenly, he became a model student in mathematics (he later obtained his doctorate in physics at the early age of 22) and he managed to join the pioneering "Spaceflight Society". It was the early Thirties, and, in spite of the optimistic name, the rockets could not reach more than one kilometre of altitude; and not only this, during a demonstration launch organized to find funding, the rocket of the group crashed onto a police hangar, thereby setting fire to it. If that incident practically marked the end of the society, on the other hand there was also the beginning of the ascent of the young von Braun, who shortly later signed an agreement with the government to secretly work on rockets for war purposes. At Peenemunde, a village on the Baltic, von Braun had at his disposal, first, a base to carry on his projects, and later a factory for mass production: in 1942, the birth of the first "space vehicle", namely, a prototype of the V2, could be welcomed. Von Braun was accused of sabotage due to some considerations about the run of the war and his true interests (i.e. space travels), and he escaped death penalty by a hair's breadth. We are at the threshold of 1945 and at the end of the first life of the boy from Wirsitz: more than one thousand V2 were dropped on England, but this did not change the outcome of the war; before the fall, von Braun arranged the surrender of himself and 500 technicians to the Allies. It was time to be born again. Von Braun's second life was a succession of experimental successes, firstly, under the aegis of the army, then of the U.S. government. He was transferred together with roughly a hundred collaborators to a military base in Alabama, where he directed his work to the conquest of space. In 1958, the rocket that brought the first Western satellite in orbit was a product of his team's work. Two years later, when N.A.S.A was founded, he became its first director: he launched the work on the *Saturn* project, capable of taking astronauts to the moon. Finally, on July 16, 1969, the *Saturn V* enabled the astronauts of the Apollo 11 mission to reach the Moon; one of the satellite's craters was given the name "von Braun" by the *International Astronomical Union.* The director of the Apollo program once declared that America wouldn't have been able to reach the Moon so quickly without von Braun's help; later, he rectified by declaring that without that help America would have "never" reached the Moon. The realization of a lifelong dream and the peak of success came shortly before his retirement from N.A.S.A.: the space agency's visions about the space race were too distant from his, and von Braun resigned. He died, the second and last time, of a cancer in 1977.

Alan Turing (1912)

Alan Turing was one of the most ingenious and eclectic scientists of last century, his research activities ranged from mathematics to chemistry and biology. In each field he achieved significant results and often with remarkable applicative consequences. For instance, during World War II, he was the code-breaker who led the deciphering of the code used by the Nazis to protect communications. This gave the Allies a conspicuous strategic advantage, insomuch as many historians share the view that the breaking of the "Enigma code" is one of the most important contributions to the successful outcome of the war. In biology, he focused on the formulas related to the morphological development of living organisms, whereas in chemistry, he analysed the nonlinear equations concerning thermodynamics, and these studies paved the way to Nobel prize for other researchers in the following years. Alan Turing committed suicide in 1954 at the age of 42 (by biting a cyanide apple), apparently due to the humiliations he received for his declared homosexuality. Many scientists (from Gottfried Leibniz onwards) can be numbered among the fathers of the current computers. Nonetheless, Alan Turing is the "daddiest" of all: his theoretical work on the concept of Universal Machine underlies any electronic computers of the past, present and future ("future" at least in the sense in which we presently intend electronic computers). Their functioning rests on the logic that was entirely envisaged by Alan Turing: after him, it was "merely" necessary to increase the power and efficiency in terms of dimensions of memory and speed.

Milton Friedman (1912)

Milton Friedman, Nobel prize in 1976, was an outstanding economist, political thinker and divulger, and one of the most prominent figures of liberalism to the point of significantly influencing the choices made by the English and the U.S. governments, with remarkable consequences on the economy in the following Eighties. By further developing the economic thought of Friedrich von Hayek, in particular as far as its applicative implications are concerned, Friedman became the epitome of the absolute rejection of any state intervention in the economy, as he was an ardent supporter of free market and a *laissez-faire* policy. Particularly interesting is the idea that the approach of tackling poverty which is based on resource redistribution turns out to be detrimental since, by violating the freedom of the individuals involved, it produces an outcome inferior to the initial situation. Friedman's criticism was also directed towards the paternalistic health-care system whose costs, being it often inefficient, end up be borne mainly by the poor as the well-off tend to opt for the major efficiency of private institutions. Finally, considering education as a public good (in the sense that it confers benefits that are not limited to the individual exploiting it), Friedman suggested a clear separation between the funding and management of the education service. The essential idea is that the state should naturally promote a minimum level of education, but providing parents with school vouchers to be spent for the provision of such services in the institute which they deem conforming to the cultural values of the family: this would on the one hand ensure the plurality of values, which is necessary in the context of liberal democracy, and on the other it would prevent the rise of ideologies. Among his numerous publications is the particularly thought-provoking "Free to Choose", written with his life in 1980.

Francis Crick (1916)

If it is true that most biological phenomena acquire a full meaning only when put into an evolutionary perspective, then it is surely equally true that the study of evolution and the heredity of traits attained its modern character with the advent of DNA. It is probably safe to affirm that the 1953 discovery of "the double helix" was the most far-reaching event in the history of biology. Francis Crick was one of the two main generators of such endeavour. He was born in England in 1916, he developed a very precocious interest in science and at the age of 12 he informed his mother that he no longer intended to go to Church. After earning a degree in physics, he failed to be admitted to Cambridge to continue his academic career. The Second World War interrupted his studies; Crick worked, and quite successfully, in the field of magnetic and acoustic mines. By the time he left the navy, he had read "What is Life", the pioneering book by Erwin Schroedinger which had a profound impact on him; in 1947, he left physics to devote himself to the study of biology practically from scratch. Later, he asserted that moving from "the elegance and deep simplicity" of physics to the "elaborate chemical mechanisms that natural selection had evolved over billions of years" is "almost as if one had to be born again". However, his studies in physics were all but futile: they enabled Crick to develop the firm belief that the scientific view of the world is substantially correct, and that significant advances could also be made in the other empirical sciences. His attention was mainly drawn to two issues: on the one hand, how life originates from non-life, on the other, how consciousness emerges from cerebral activity. As far as the first question is concerned, Crick already had two-thirds of the solution available to him: Charles Darwin's selection theory and the studies of Gregor Mendel. Thus, he was left with the task of completing the puzzle, with thee discovery of the molecular bases of genetic information. In 1951, he started working with the then twenty-three-year-old James Watson at *Cavendish Laboratory* at Cambridge. Drawing upon the X-ray diffraction results of the previous researches conducted by Maurice Wilkins and Rosalind Franklin at *King's*

College, on April 25, 1953, Crick and Watson published their article on the double-helix molecular structure of DNA in *Nature*. For this groundbreaking discovery the couple was jointly awarded the Nobel Prize in Physiology and Medicine with Wilkins in 1962. In the following years, the researches carried out by Crick led to significant results in molecular biology, in particular on the subject of genetic code and protein synthesis. In the mid-Seventies, the focus of his interests moved to the second major problem of his intellectual mind, namely, consciousness; from 1976 onwards, he worked at the *Salk Institute* at La Jolla, in California. It was a fresh start: after self-teaching the results of the budding neurosciences, in the Eighties, Crick began orienting himself in the numerous sub-disciplines concerned with cognition and he published several hypothesis about the functioning of visual awareness; in a period in which the subject was often considered taboo among scientists, Crick was not afraid of speculating that now science has the instruments necessary to undertake a reduction of mental operations (including consciousness) to the brain. In the sensational double-helix couple, the physician was the first to depart: Crick died of cancer on July 28, 2004.

Richard Feynman (1918)

Coming to know that the biography of the 1965 Nobel Prize Laureate in Physics has the title "Surely You're Joking, Mr. Feynman!" is the perfect introduction to the figure of Richard Feynman, who loved to describe himself as "Nobel Prize winner, teacher, storyteller and bongo player". Ever since he was a child he had displayed a great interest in pure and applied sciences, in high school his performances in mathematics contests were somewhat legendary. Nevertheless, his admission to university revealed more problematic than one may think: in spite of his mastery in mathematics and physics, his curriculum also displayed some deficiencies. On the other hand, his Jewish origin did not make the matter any easier:: after being rejected at *Columbia University*, Feynman was admitted at MIT. The struggle for the postgraduate entrance seemed to repropose all the bad omens encountered in the failed admission process at Columbia: at Princeton, he introduced himself to the examining commission with the highest scores ever achieved in the university in mathematics and physics, coupled with the worst possible ones in literature and arts. However, the university ended up accepting the exuberant physicist: in 1942, he completed his Ph.D under the supervision of John Wheeler. In the period between 1942 and 1945 he participated in the Manhattan project to develop the atomic bomb; as a junior physicist, it seems that his overall role was not a crucial one. From the Fifties onwards, Feynman taught physics at the *California Institute of Technology*, elaborating the ideas underlying his doctoral thesis and making contributions mainly to the development of quantum mechanics and to the comprehension of the interaction between particles: his works concerned with the spin of particles and his ideas about the "*partons*" represented a remarkable step forward for physics. In the years following the Nobel Prize, Feynman developed significant ideas instrumental to studies on superconductivity, superfluidity, radioactive decay; he was one of the first scientists to publicly speak of quantum computations and he played a central role in the development of the first parallel processor computers. Finally, he was the first to understand the possibility of a radically new kind of manipulation of matter: he was the first to conceive the ideas underlying nanotechnologies. He died on February 15, 1988, telling his sister that he would have hated to die twice because it is really boring. The statement with which it is fair to remember one of the great players of our time is obviously his: "what I cannot create, I do not understand".

Isaac Asimov (1920)

When asked what I would do if my doctor told me I had only six months to live, I answered "I'll just type faster". Isaac Asimov was born in Petrovichi (Russia) on January 2, 1920 and he arrived to New York with his family three years later. He came to know *Science Fiction* magazines at a very young age thanks to the small commercial activity managed by his parents; at the age of eleven, he began his activity as a writer, which was bound to be an exceptional one both in terms of quantity and quality: the year 1934 saw the publication of his first story, while he was still at high school. *What I will be remembered for are the Foundation Trilogy and the Three Laws of Robotics. What I want to be remembered for is no one book, or no dozen books. Any single thing I have written can be paralleled or even surpassed by something someone else has done. However, my total corpus, for quantity, quality and variety can be duplicated by no one else. This is what I want to be remembered for.* He studied chemistry and biology at *Columbia University*, where he also earned a Ph.D in biochemistry in 1948. In 1942 he got married right before being enlisted as a chemist in a Navy base in Philadelphia. It wasn't before the end of the war that his first novel came to light: "Pebble in the Sky" was published in 1950. Alternating teaching at the *Boston University* with his activity as a writer, in the Fifties he published the celebrated "Foundation Trilogy". *The most exciting phrase to hear in science, the one that heralds new discoveries, is not "Eureka", but "That's funny".* In the Sixties, when he had already left his university chair, he interrupted his activity as a writer in order to, in a way, go back to teaching: most of his essays and of his divulgative publications on chemistry, biology and physics date back to this period. For him, science popularization was a natural tendency, an obvious complement to his activity as a writer of science fiction: *I desire to explain, and my greatest satisfaction is to take something reasonably intricate and make it clear step by step.* In 1970 he separated from his wife and he remarried three years later. In the Eighties, under the pressure of his publishing house, he wrote again for the Foundation Cycle, while continuing his work on the robots. *Life is pleasant. Death is peaceful. It's the transition that's troublesome.* His heart gave up on April 6, 1992, but it was only years later that his wife publicly revealed that the writer was affected with HIV, which he had contracted from an infected-blood transfusion during a surgical intervention to his heart that was weak all along. *If knowledge can create problems, it is not through ignorance that we can solve them.* Isaac Asimov left us with approximately 500 works, among manuals, essays, articles, short stories and obviously novels. Our collective imaginary owes an incalculable debt to his imagination and his intelligence. The lucidity, the unbiased rationality and the scientific rigour with which he depicted the future and explained the present render him a one-of-a-kind player.

Federico Fellini (1920)

Federico Fellini was a genius endowed with an artistic sensibility that is very difficult to equal, a deeply inspiring figure both for his contemporaries and, far less obviously, for successors as well. His artistic career began as a caricaturist, reflecting his long interest in the magical world of irony and his talent for grasping the essential personality traits of his characters. At the early age of seventeen, he entered into partnership with a painter to open a shop where they drew caricatures of the vacationers. In two years, he started collaborating with renowned newspapers and magazines of his time, thereby coming into direct contact with the show business. During the drafting and the scenic representation of one of his earliest scripts, when he was aged twenty-three, he met his other half Giulietta Masina, with whom he shared the rest of his life. From his first work to his last Federico Fellini achieved success one way or another. Particularly remarkable were the quantity of films he made and the number of Oscars he won. Besides the indisputable technical ability, Fellini's genius lies in his superior capacity to dissect human passions and obsessions and to render their strength and magnitude in a particularly effective manner. The final scene of "8 e ½", the room of "Juliet of the Spirits", the party of "La Dolce Vita", together with at least some twenty other scenes will always hold a special place in the history of cinema and in the mind of those who saw them.

Luigi Verzè (1920)

He was born in Verona in 1920 and, in 1947, he graduated in Letters and Philosophy in Milan. It was just one year later that, in disagreement with his father, he was ordained a priest and he founded the first Centro di Addestramento Professionale (Professional training center) for kids. In the pages of his biography, Don Verzè elucidates his concept of mission from a Christian point of view: "As there is no man's sin that another man cannot commit, so there is no good deed that anyone of us is not able to accomplish. It suffices to put all of our flesh in the service of the others' flesh. The rest is done by the Top Manager. The one who stands above us". From the very first steps, his great visionary project, to which he has been devoting his whole life, consists in setting up new hospital structures aimed at care in the broadest possible sense. In 1958, he founded the Associazione Centro Assistenza Ospedaliera S. Romanello (S. Romanello Association Hospital Assistance Center) for the care of children and the elderly, also endowed with a housing complex. It is again in Milan, where by then he had permanently moved, that he built the San Raffaele Hospital which was bound to become a leading reference structure for Italy and later for the entire world. The ingenious idea standing at the very foundation of the San Raffaele is to combine healthcare, research and education and to run these according to purely managerial criteria; the whole forms a macrorganism that tends to be self-managing and self-completing. From 1980 onwards, he devoted himself to the expansion of his great project, both in terms of "quality" and "quantity": the central body of the San Raffaele was complemented with numerous specialized centers and analogous clinical institutions in several parts of the world. His central focus constantly remained the formation of people and their well-being: in 1996, he launched the Vita-Salute San Raffaele University and in 2007, the *Quo Vadis* center. With the *Quo Vadis* Don Verzè intends to offer a new approach to the concept of treatment and health maintenance: starting from the sciences of the body and the lessons that genetics may teach us about our destiny, exploiting the useful tools of psychology and neurosciences to understand and cure our mind, and finally investigating in depth the spiritual and existential aspects of our lives, Don Verzè bets on the possibility of significantly increasing the quality and the quantity of the days ahead of us. It is not inconsiderate to state that the school, or better the gym at the service of well-being" *Quo Vadis* may represent an important experiment in the long path towards semi-immortality.

Lofti Zadeh (1921)

In the Phaedrus, Plato proclaimed the art of sorting things into classes, dissecting the Being along its natural veins, avoiding to be incompetent butchers by inadvertently riving some portions. Unfortunately, on a close inspection, the world does not appear as characterized by clear boundaries, but rather by grey zones: in the process of evolution, what is the area of transition from monkeys to man? How much hair must a person have to be qualified as bald? What is that distinguishes a living thing from a non-living one? Questing for the natural veins in this jungle of shades may not only be extremely tiring, but even senseless. The man for this job is Lofti Asker Zadeh, mathematician and computer scientist at the University of California. He was born in Baku, Azerbaijan, to a Russian mother and an Iranian father, and his education was divided between Teheran and the United States: the "mix" that characterized his formation may contribute to explain his distrust of the concept of clear-cut boundary. In 1965, he published his pioneering paper on *fuzzy* sets, a few years later, in 1973, he introduced his *fuzzy logic*. If, as aforementioned, the definiteness of Plato's Hyperuranium is not of this earthly world, Zadeh's efforts are directed towards a mathematically precise characterization of those grey zones of Being which we have to confront with in our reasonings every day. The idea is essentially simple and intuitive: classically, given a set and an individual, such individual either belongs to the set or not. We may think of this elementary fact as a membership function that gives 1 for the former case and 0 for the latter. The *fuzzy* approach is obviously far more "liberal": for each individual and each set, our membership function is allowed to assign any real number in the interval [0,1]; for instance, a human being belongs in degree 1 to the set of the living, a virus in degree 0,5666, a stone in degree 0. This type of move, taking the shape of a generalization of what occurs in classical logic, is the instrument proposed by Zadeh to model the imprecision of reality.

Paul Watzlawick (1921)

Paul Watzlawick was an Austrian psychotherapist who was very active in many domains. Particularly known for his studies on language, in the Sixties and the Seventies he was one of the leading figures of the school of Palo Alto. His cognitive behavioural approach was mainly focused on the constructivist and strategic model of knowledge, of which he was one of the founding fathers. He authored many successful manuals such as "The situation is Hopeless, but not Serious: The Pursuit of Unhappiness". In 1987, he founded with Giorgio Nardone the CTS (Center of Strategic Therapy) in Arezzo. One of his major contributions is the formulation of the concept of meta-knowledge, with this term Watzlawick defined the knowledge of the nature of knowledge and the comprehension of the dynamics triggered by the learning processes. In "Pragmatics of Human Communication", the author distinguished three levels of knowledge: the first is the knowledge of things, the second pertains the knowledge of the first-level knowledge, i.e. meta-knowledge. In a recursive way, the third level represents the knowledge of the second-level knowledge; this level represents the awareness of one's own meta-knowledge, by means of which the individual formulates a vision of the world in relation with her own self-conception. At each level, the consideration of given objects and events gives rise to models that are employed to deal with analogous objects and events or to compare other different ones. Watzlawick's ideas perfectly reconcile with our model of the three minds, of meta-minds, the spiral of knowledge and of meta-self-reference.

Benoît Mandelbrot (1924)

Mandelbrot was born into a Jewish family of Lithuanian origins, in 1936, he moved to France where he completed his education under the mentoring of his uncle who was a professor of mathematics. Mandelbrot has always considered this "non-conventional" education as more important with respect to the formal one (during the Second World War he was able to attend school only sporadically). All along, his main quality has been the ability to provide a representation of any problem by means of a visual-geometric approach. During the Sixties, he began testing the first computer graphics programs and "translate" the most complex mathematical theories into the apposite language. In 1975, he coined the term "fractal" (from the Latin "*fractus*", meaning broken) and this made him famous and recognized on a world scale; the geometry derived from these bizarre objects is precisely called fractal geometry. A fractal is a recursive mathematical-geometric concept used to describe what in technical terms is generally defined a "scale-invariant fractionary" curve, namely, that repeats itself to infinity maintaining the same characteristics at each level of magnitude. In a nutshell, the details of a given fractal are similar to the structure in its entirety (such feature is also named self-similarity: a part of the object is similar to the whole). This mathematical discovery has a momentous import because, apparently, many aspects of reality would be characterized by these particular structures: nature often contains recursive repetitions of identical patterns on a smaller and smaller scale. One of the most renowned examples is that of the fir tree, in which each branch approximately looks like the whole tree, and each twig is in turn similar to its branch. Furthermore, it was recently conjectured that the human being easily recognizes the fractals in nature and is fascinated by the beauty of these objects because also the mind's structure share some similarities with them. Another interesting hypothesis proposes that the Universe itself is nothing but a huge fractal. Beyond purely mathematical, physical, or financial implications, Mandelbrot's greatness exactly lies in his providing us with an extremely powerful conceptual interpretation tool which may enable us to open some of the yet locked doors on the way towards the description and the understanding of the functioning of reality as a whole.

Marvin Minsky (1927)

Marvin Minsky is justifiably regarded as one of the gurus of

AI, being among the leading figures of the historical Dartmouth conference in 1956 (the event that saw John McCarthy coin the term "artificial intelligence"). According to Minsky, the discipline should be aimed at "making machines do things that would require intelligence if done by men". Minsky studied mathematics first at Harvard and then at Princeton and he came to investigate practically all of the facets of AI: from the theoretical foundations of computability theory, to applicative studies in semantics, perception, learning and representation of knowledge. As an inventor, he can claim the merit of building the first neural network capable of learning (called SNARC, *Stochastic Neural-Analog Reinforcement Computer*) in 1951, and of holding the patent for the *Confocal Scanning Microscope*, an optical instrument with a resolution that was unprecedented at the time. Perhaps, the most significant contribution to AI was the introduction of *frames*, as a way to manage a particular kind of knowledge possessed by human beings. When we think about a concept, we typically visualize a representative example of that concept: for instance, we associate the idea of scientist with a white-haired individual wearing spectacles and a gown. *Frames* are tools elaborated for this type of information collections, i.e. "frames" of attributes related to a concept; inasmuch as, obviously, an individual that represents an instance of "scientist" cannot share all the characteristics of the prototype, it is essential for the *frame* to have the capability of rewriting the default information that is related to it. From the Seventies onwards, Minsky has worked on a theory of mind called "The Society of Mind", which became known to the public at large thanks to the namesake book; in these works, he is a veritable pioneer in elaborating the idea that intelligence is not the product of a single mechanism, but rather the result of the ordered interaction of different types of small agents, each designated to perform a specific and narrow range of tasks (it is not hard to identify hints of this thought in Daniel Dennett's philosophy and in the researches on AI conducted by Douglas Hofstadter). In 2006, Minsky published "The Emotion Machine" where he argues that each of our most relevant emotions results from the activation and the deactivation of different mental activities, and such activations and deactivations radically modify the way in which the brain responds to stimuli. In other words, a mind at a given time is simply seen as a set of *resources* that interact, and this set changes from moment to moment, thereby determining our emotional profiles. "Models of reference", perhaps…? What an honour, uncle Marvin!

Desmond Morris (1928)

Morris is a notable English ethologist who devoted his life to the comparative study of human behaviour and that of the other primates. In his works, he emphasizes the biological and behavioural continuity between man and apes. The leitmotif of his considerations can be expressed in a nutshell by the following reversal of viewpoint: "look at man through the eyes of the ape". Thanks to this change of perspective, it is possible to assign a new meaning to the theories concerning human behaviour. However, his career does not exhaust itself in his interest in research, but it is complemented with a remarkable divulgative effort which led him to become one of the most influential and listened-to points of reference in his field for the audience of non professionals, managing to strike a balance between scientific rigour and narrative simplicity and clarity. Within the scope of Morris's personality, there is also room for an artistic vein that finds expression in his passion for surrealist painting. In 1957, he organized an exhibition of the drawings made by a group of chimpanzees, and some of the works realized by a chimp called Congo achieved a great success among critics, artists and the public.

James Watson (1928)

James Watson grew up in Chicago with a passion and a gift; the former is ornithology, the latter is an extremely precocious intelligence. At the early age of 15, he started his university studies in zoology: in 1946, he underwent an analogous experience to that of Francis Crick, namely, he read and was fascinated by Erwin Schroedinger's book "What Is Life?". So Watson decided to change his course of study to specialize in genetics. Thanks to his studies of the effects of X-rays on bacteriophage multiplication, already in 1950, he earned a Ph.D in zoology. After a brief but instructive period of research in Copenhagen, Watson moved to the *Cavendish Laboratory* of Cambridge University, while the experimental results had led him to believe that the molecular structure of DNA was about to be discovered. However, the most preeminent biological discovery of the century (and one of the most important in history) required the joint efforts of several people; in particular, the year 1951 marked his encounter with Crick and the beginning of their collaboration which resulted of a truly pivotal importance, In 1952, the young Watson and his colleague were officially assigned the task of studying the effect of X-rays on tobacco mosaic virus. Nonetheless, for the couple of biologists the temptation of DNA was too strong to resist: it was to this objective that their studies and their efforts were constantly directed; curiously, in 1954, Watson demonstrated that also tobacco mosaic virus has an helical structure. Playing with the models of the four nitrogenated bases of DNA, Watson realized that adenine and thymine on one side and cytosine and guanine on the other are linked by structurally similar hydrogen bonds. According to the models available to Watson, besides being perfectly "natural", this pairing has the merit of providing an explanation for a previous discovery made by Erwin Chargaff, namely the experimental proof that in a DNA molecule the quantity of adenine is always equal to the quantity of thymine and the quantity of cytosine is always equal to the quantity of guanine. Too many coincidences not to believe that this was the right direction for the solution. In fact, a short time later, relying on Maurice Wilkins and Rosalind Franklin's works on X-ray diffraction, some of which unpublished, in 1953 Watson and Crick published their paper on the double-helix structure of DNA on *Nature*. In 1962, Watson, Crick and Wilkins were awarded the Nobel Prize for Physiology and Medicine in recognition of this outstanding discovery. In the following years until the end of his career, his main experimental interest was to investigate the role of RNA in protein synthesis. Watson is also an esteemed writer, in his 1968 book "The Double Helix", he not only narrated the story of the discovery of DNA, but also gave a glimpse of the private stories and the personalities of the individuals involved, thereby conveying an unusual picture of the dynamics of scientific research. And he is any less brilliant in scientific publications: "The Molecular Biology of the Gene" was a very successful manual. Our hope is that his memes, certainly through more tortuous paths than their "cousins" genes, might manage to spread and be transmitted along generations, at least until the next, stunning James Watson.

Humberto Maturana (1928)

Maturana is a theorist of biology and cybernetics, a series of experimental analysis conducted in his laboratory of Santiago of Chile led him to elaborate, with his student Francisco Varela, one of the most interesting and innovative theories on the interaction between mind and body: the theory of autopoiesis based on the concept of system. First and foremost, Maturana conceives knowledge as a purely biological phenomenon, therefore explicable and understandable only as such; hence, he defines learning as an autonomous process of self-organization which is developed by the organism. On the one hand, each organism is considered as a closed system, defined on the basis of its internal organization, inasmuch as it has no reference but itself and as it tends to perceive the external world as a set of disturbances to which it constantly responds in a perspective of self-production; on the other hand, each organism is also seen as an open system, since its behaviour depends on the disturbances of the environment. In this view, reality is an arbitrary construction that starts to exist only upon the consensus (obviously supported by the real occurrence of the phenomenon) and the agreement about it on the part of a given community. Clearly, in these terms, the meaning of the elements of reality does not exist in a strictly objective sense (the access to a unique reality independent from the observer is rejected, what is proposed is rather the existence of "many realities" as forms of living that originate from each being); each observer's observation would always be the result of a relation between its inside and outside. Furthermore, Maturana elaborated other concepts typical of our common sense to make them consistent with his model of reality. For instance, emotions would correspond to (always biological) internal changes of configuration; adaptation would be a coefficient of compatibility between the structure of the reference system and the environment; autonomy and control would be part of our knowledge of the system, thereby ceasing to be characteristics of the system itself; language would be the ability to provide an explanation of the real and it would be the only truly relevant property distinguishing a system man from an animal one. Finally, within his particular perspective, the scientist confronted with the theme of love: a biological relational phenomenon consisting in those conducts through which the other emerges as a "legitimate other" searching for coexistence; it is only in these circumstances that a system can be itself and it becomes ill if this particular "property" vanishes.

Piero Angela (1928)

We still remember the condescending smiles with which most "professional academics" used to greet us when, at the end of the Seventies, we dared to praise Piero Angelo for his activity of science education, as if there were the will to maintain that a book or a television program accessible to the public at large could not be at the same time rigorous and a source of inspiration for professionals. What makes a player great is the ability to get to the essence of a problem and, also in the case of Piero Angela, time helps to measure his actual prominence. Among his memorable contributions we have to mention his struggle against false science of the so-called paranormal phenomena, his attention to the period of child development from birth to three years of age and the aspiration to the resolution of many social conflicts thanks to the "tension towards knowledge". He has always been probably too intelligent for the academic world and too transparent for the political arena: a perfect education minister in a future society of semi-immortality.

John McCarthy (1929)

Artificial intelligence, a compelling discipline for the growth and the realization of the cognitive paradigm, owes its name to "Uncle" John McCarthy. In fact, it was him to coin the term "artificial intelligence" to denote the field of studies which publicly emerged in the historic Dartmouth conference of 1955-56. McCarthy studied mathematics at Caltech first and at Princeton next, and he worked at Princeton, Dartmouth and MIT before settling at Stanford in 1962 in whose laboratory he spent his whole academic career until his retirement from teaching. Ever since the Sixties he has provided remarkable contributions to theoretical computer science, working on the development of a mathematical theory adequate to the area of computation. And more than this: already in 1961 he conjectured that in the future, by means of *time-sharing* technology, computations and computer applications could be sold just like services such as water and electricity. This idea was partly forgotten from the Seventies onwards due to technological delays, while it recently seems to be back in fashion. However, his most significant works are those concerning the domain of artificial intelligence. He has the merit of inventing the programming language LISP, which had long been singled out as the most commonly used language in AI research, and which today, in spite of its age, is still appreciated in the sector. In the complex debate that originated during the Seventies concerning the representation of knowledge, McCarthy has been from the very beginning a major advocate of the symbolic approach: in fact, logic is expressively powerful, mathematically treatable, and, by its very nature, it allows to deal with facets of knowledge such as compositionality and the production of new information on the basis of known premises in a fairly uncomplicated manner. A considerable portion of his researches involves the formalization of what seems particularly problematic to lend itself to a representation by means of a symbolic language, namely the (implicit, unaware, reviewable, unsophisticated) knowledge of common sense, notions that are essential to enable us to move in the world with intelligence. Thanks to his relation with *computer science* in general, and AI in particular, Uncle John was awarded numerous recognitions including the *Turing Award* in 1971 and the Benjamin Franklin medal for his studies in computer science and cognitive sciences. With a confidence and determination that are equal to his passionate defence of the use of logic in AI, John McCarthy has always cleverly promulgated the sustainability of technological development, showing how development is not only desirable but also possible for humanity as a whole.

Harold Bloom (1930)

Our opinion of critics, and literary critics in particular, found a watershed in our encounter with Harold Bloom. His analysis of the creative genius in the literature of all times displays a really exceptional efficacy, providing confirmation to the hypothesis that only a truly intelligent person can enable us to understand the personality of a great artist in its essence. In his book "Genius: a Mosaic of One Hundred Exemplary Creative Minds", he performed a detailed examination of one hundred writers selected as the greatest ones, where the greatest among the greatest is William Shakespeare, followed by Dante Alighieri. Some of his unconventional stands often make him generally unpleasant to the public at large: for instance, a position that is not easily understandable is his poor consideration of the Harry Potter's saga, which, in Bloom's view, is a kind of literary profanation. Only time will tell who is in the right, whether him or millions of overeager readers. For those strange cases of life, he is a childhood friend of Marvin Minsky.

Roger Penrose (1931)

Although Roger Penrose is considered one of the champions of the "weak" version of artificial intelligence, our esteem towards him is certainly strong. For instance, we deem his book "The Road to Reality" as the very best of what has been produced lately in the field of the popularization of the fundamental laws of the physical universe. Penrose is a physicist/philosopher, a great player in the two domains that are crucial for the Solution of the Game, namely the field of physics and that of human mind. His theory of *twistors* in the area of physics and that of consciousness in the cognitive one are both approaches that, even without providing conclusive solutions, nevertheless involve a remarkable innovation content and an intellectual stimulus for everyone. Being truth our primary value, we are not that interested in academic disputes: even starting from a very similar description of physical reality, we think that artificial intelligence will be able to equal man's mental faculties, Penrose does not. In the following decades we will see who is right and who will have to change his mind.

Edward de Bono (1934)

He graduated in medicine and psychology, and he is known at a global level thanks to his studies on thought and creativity. His work also extended to the business world, in fact he can number among his clients many of the most important multinational corporations. Among the most famous books he published, we want to mention "The Use of Lateral Thinking", "The Mechanism of the Mind", and "Six thinking Hats". Edward de Bono is credited for singling out that particular form of thought that is precisely termed "lateral thinking". When we are confronted with a problem of any type, if we try to deal with it merely in a conventional manner (according to the patterns we are familiar with), we tend to achieve results that are fundamentally correct, but limited in scope. On account of this, it is often necessary to turn the reasoning upside-down, mix the hypotheses or even get rid of the initial premises and rely on free associations, also the random ones: in a nutshell, one has to "move around the obstacle", surrender to the laterality of creative thinking. Obviously, "moving around the obstacle" does not mean to escape the problem, but it rather implies to carry out a reasoning that, although its first steps have nothing to do with the solution, turns out to be crucial to gain a new perspective on the situation, which will enable us to remove the obstacle or to find new paths towards our objective. This discovery, which had already been explored in various traditional areas of Eastern culture, allows to highlight the relevance of lateral thinking in the complex definition of human intelligence.

Tenzin Gyatso (1935)

Tenzin Gyatso ("Ocean of wisdom"), is better known as the fourteenth Dalai Lama, the spiritual and temporal leader of the Tibetan people. Since he places a high value on the exchange between modern science and ancient Buddhist knowledge, Gyatso never misses the chance to couple his political and religious activity with an open discussion with scientists from all disciplines, from particle physics to Big Bang Theory, from mathematics to logic. As far as neurobiology is concerned, he often emphasizes how Buddhism develops within its realm a profound understanding of the human mind, the emotions and thoughts. In particular, through the techniques of the Tantric discipline, Buddhism teaches how to control the body by controlling the mind. In this context, meditation is used as the fundamental tool to attain the development of the perceptual and self-referential abilities of the mind. Tenzin broke a millenary tradition, according to which succession is established by means of the interpretation of signs and challenges that the candidate have to overcome, by proposing that his reincarnation would be democratically chosen through a conclave of the most important Lamas (similarly to what occurs with the selection of the Pope).

Robert Ader (1939)

Ader is among the founding fathers of psychoneuroimmunology (as well as the inventor of the term). Ader graduated in psychology and he devoted himself to the study of the interaction between the immune system, emotions and psyche. With great scientific intuition, he was drawn to conjecture, and, later to demonstrate, that the immune system can be influenced by the same instruments brought to light by Ivan Pavlov's experiments. By conducting an experiment using mice, Adler surprisingly managed to reproduce a Pavlovian conditioning on their immune system. When he was asked about the origin of such an idea, Ader replied: "It was inconceivable to think that the two principal defence systems could act independently without exchanging information". Paradoxically, his limited knowledge of immunology gave him an advantage in his researches: in fact, his studies take nothing for granted and each prejudice is called into question. In the last decades, his discoveries have modified the very notion of illness, by revolutionizing the operational approaches to the treatment of AIDS, cancer, leukaemia, multiple sclerosis and all the diseases of the immune and nervous system. His studies paved the way for numerous further researches aimed at the systematic investigation of the human body and its illnesses.

Richard Dawkins (1941)

Richard Dawkins attended the University of Oxford until he earned a Ph.D in ethology and zoology (in which he later became a professor, always at Oxford). In 1976, his best-seller "The Selfish Gene" marked the beginning of his intense activity as a science popularizer. This work proposes an alternative view of evolution, by assigning the gene the role of protagonist of natural selection (in contrast with the classic individual-centric view that had prevailed so far). This shift of perspective would allow to provide an explanation of some altruistic behaviours displayed by animals, which appear to contradict the law of survival of the fittest: in some instances, it seems that evolution operates for the good of the species and not of the single individuals. Dawkins observes that these phenomena are susceptible to a different explanation if the focus is moved to the genes rather than the individuals: the gene is the fundamental selection unit; in this perspective, men themselves would be nothing but survival machines for the gene, "robot vehicles blindly programmed to preserve the selfish molecules known as genes" and, obviously, to maximize the number of replications possible. Therefore, the principle of "*bellum ominum contra omnes*" governing the Darwinian view of evolution is, in a sense, preserved, by simply modifying the observer's point of view: it was the genes to create us as a whole, body and mind, and this is precisely the reason why the ultimate goal of our existence must be their perpetuation. Besides the new perspective of "genic reductionism", we also owe Dawkins another revolutionary and purely reductionist standpoint from which to look at the world, with the creation of a new discipline, i.e. memetics. The underlying idea is that there exist units of transmission of culture (what we usually tend to refer to with the term "ideas"). The strongest among these units tend to acquire a sort of life of their own through their propagation from mind to mind until they develop the need to replicate and spread. The strength of any meme (an ideology, a religious doctrine, a refrain, an idiom, a scientific theory, etc...) does not reside much in its content (whether the idea carried by the meme is profound, superficial, true or false is irrelevant), but it rather lies in the main models of reference (related to survival or to the culture) which it is able to stimulate. In 2006, he published "God Delusion", as the ideal completion of his view of biological and social reality. The central thesis of this work is that any form of creative intelligence would come to exist only as the finished product of a long and gradual evolutionary process (natural selection would therefore be the alternative to creation). Furthermore, another element worth of interest is his attempt to give a plausible explanation for the fact that in the third millennium the phenomenon of religion is still present everywhere: consistently with his theory of memes, Dawkins considers religion as a possible by-product of something very useful to the survival of our species, analogously to what happens with certain physical characteristics of animals, which were not directly selected by evolution, but are simple side effects of evolutionarily useful attributes.

Douglas Hofstadter (1945)

What gave Douglas Hofstadter his notoriety among the public at large was the late-Seventies best-seller "Goedel, Escher, Bach: an Eternal Golden Braid", in which the author unveils a complex network of fascinating and intricate connections among art, language, logic, biology and artificial intelligence. The American scientist is the son of a Nobel-Prize winner for physics, and both his education and his interests are truly heterogeneous: he graduated in mathematics and earned a Ph.D in physics, he self-taught logic, plays the piano, speaks five languages (English, Swedish, Italian, French and German plus a little bit of Russian) and he won the Pultzer Prize in 1980. For two years and a half, he had written a column of mathematical recreation on *Scientific American* magazine, where he had incessantly kept on surprising with his mathematical games; he has a keen interest in puns, anagrams and ambigrams (designs that may be read differently according to the standpoint). The common thread of his work is the interest in the human mind, the subtle mechanisms with which it works and creates. At variance with the community of researchers in the field of AI, his computational models were directed at the exploration of man's creative and analogical abilities: for instance, Letter Spirit is a program that generates an alphabet of a certain style starting from a few example characters. He also discovered a law, which is obviously built on a self-referential statement, namely, the Hofstadter's Law: "it always takes longer than you expect, even when you take into account the

Hofstadter's Law".

Hunter Patch Adams (1945)

His life was smoothly portrayed (although with some cinematographic license) in a 1998 movie. As a boy, suffering from a strong depression, he was forced to spend a prolonged period in a clinic for mental illnesses. It is from this experience that stemmed his idea of complementing medical care with a "laughter therapy", understanding how crucial a role is played by happiness in the process of healing. In 1962, he began his studies in medicine, with the hope of using it to change society. After graduation, in spite of numerous problems with medical orthodoxy due to his innovative style and his "excess of gaiety", he has always devoted his life to humour therapy. All along, Adams has used medicine not as a response to a problem (the disease), but rather as a life experience that involves two individuals, both endowed with the ability to mutually help each other. Curing does not mean the mere administering of the right medications, it also and foremost implies to take care of someone, helping her to live better: in his view, we all are a bit doctors and patients. The year 1971 saw the beginning of the realization of his dream, the construction of the Gesundheit Institute (the German term means "science of health"), which is a free hospital in West Virginia, designed to welcome whoever is in need.

Deepak Chopra (1946)

Deepak Chopra was named by Time magazine as one of the one hundred most influential people of last century. He was born and raised in New Delhi, India and in 1970 he moved to

Boston to continue his studies in endocrinology. Deepak Chopra is the embodiment of one of the most significant attempts to merge Western scientific culture with Indian spiritual and healing experience. Currently, he is one of the most highly regarded experts in the field of Ayurveda (science of life) holistic medicine and of alternative therapies considered in light of his interpretation of quantum mechanics. Deepak Chopra's therapeutic intervention involves the employment of the transcendental meditation of the Indian guru Maharishi Mahesh Yogie and the most advanced self-referential techniques. Chopra introduced a therapeutic paradigm that has radically changed the very meaning of the term "health". By health, he means not merely the absence of disease, but rather a condition of balance between body, spirit and mind.

Daniel Goleman (1946)

Daniel Goleman is an American psychologist whose main focus of study is the role of emotions in the cerebral functioning. His studies, among which the book "Emotional Intelligence" is the most widely-known, represent a reference for neuroscientists. Making a claim against traditional psychology, Goleman argued that classic intelligence tests do not take into account the emotionality of the subject. Therefore, Goleman proposed to supplement cognitive intelligence tests with emotional intelligence tests. This second type of intelligence is equally important, inasmuch as it represents the ability to manage one's own emotions and to recognize those of others. In 1972, thanks to a scholarship, Goleman spent fifteen months in India, where he undertook his first studies in the field of meditation. This experience convinced him of the importance of the study of Buddhist culture and practice. Over the years, benefiting from the collaboration of several other researchers and drawing on the most advanced tools of neuropsychological research, Goleman critically contributed to shed light on the biological mechanisms that make the various types of meditation such unique experiences, by disclosing the central role played by the control of emotions in all these techniques. The publication of his 1998-book "The Meditative Mind: Varieties of Meditative Experiences" laid the theoretical foundations of a fully-fledged research project which was bound to take off two years later. Underlying the birth of the *Mind and Life Institute*, whose affiliates include some of the world's most prominent figures in the domain of neurosciences (among many others, Tenzin Gyatso and Francisco Varela), was precisely the will to promote the dialogue between Western scientific research and the Eastern spiritual one, that is to say, between a predominantly logical culture and an essentially analogical one.

Raymond Kurzweil (1948)

For many years, we have been accustomed to know Raymond Kurzweil only as the developer of one of the best optical recognition system on the market and as one of the first researchers to seriously go into the field of sound synthesis. Then, we happened to encounter his book "Fantastic Voyage - Live Long Enough to Live Forever", co-written with Terry Grossman. Then, moved by curiosity, we visited his Internet site (www.kurzweilai.net) and we were literally given the shivers by it. To us, Raymond Kurzweil represents the definitive demonstration that individuals, who have never got in touch with each other, can nevertheless develop scientific, entrepreneurial and research paths that, with all due proportions kept, are practically matching. We regard Kurzweil as our American "older brother", we follow his interventions with the greatest attention and we systematically compare his results with ours. We share the firm belief that semi-immortality will be attained by the end of this century. Like us, he blazed a trail clearly based on technological innovation and, like us, he is convinced of the timing of the program that foresees the following steps: to maintain good health until 2030, to stop the aging process until 2060, and, finally, to reach semi-immortality by the end of the century. At the time being, the main difference between our two "recipes" lies in the importance ascribed to endogenous (mental and physical) factors with respect to the exogenous (drugs and alimentary integrators). Both our work teams obviously believe in the systemic approach, but Kurzweil's current recipe consists in taking about a hundred pills a day, whereas we seek to achieve the same results by means of mental and physical exercise and appealing to the exogenous factors in a far more limited way.

William Gibson (1948)

The year 1984 saw the publication of "Neuromancer", William Gibson's debut novel. Very simply put, in this novel the term "cyberspace" appeared for the very first time, Internet, virtual reality applied to data banks and Matrix' artificial parallel universes were neatly envisaged. Gibson is much more than a visionary, he is a fine interpreter of our time, able to translate mere pre-visual sensations into precise events. Those social fabric and relations binding both artificial and real people, which he describes in his novels, in particular "Virtual Light" and "Idoru", are taking shape in our society and with overwhelming punctuality. Gibon's brilliance does not reside only in what he describes, but also in how he describes it. His propositions trigger models of reference in a rapid and often unpredictable manner. He is perhaps too intelligent to be directly appreciated by everyone, but, nonetheless, so compelling to inspire many other artists, philosophers and technologians and through them, he enters into our minds and our homes.

Steven Pinker (1952)

Steven Pinker is recognized all over the world for the results of his studies on visual cognition and in particular on the development of language that he sees as the key means of access to the human mind ("what will probably bring us closer to the understanding of our nature"). He was a disciple of Noam Chomsky, and from his master he took the clue for his revolutionary discoveries on language. Abandoning the dogmas of behaviourism, Pinker put the focus on the necessity to "look inside the brain" in order to attain a full understanding of any form of human attitude. Language, just like any other odd phenomenon in the show of Nature, would neither be a cultural invention nor a skill that we learn from our parents: what we possess is simply an instinct among many others, i.e. the language instinct. While explicitly keeping away from the ethical implications of the matter, Pinker emphasizes the innate character of linguistic bases. In a nutshell, according to the scientist, there would exist a specific gene of language: as a result of evolution, within our brain we would have a sort of "recipe", a particular program capable of constructing an unlimited set of statements starting from a finite set of words or syntactic rules. Furthermore, Pinker reflects upon the relationship between thought and language, and he puts forward the idea of an abstract language of thought, common to all human beings and called "mentalese". This instrument would help us to shape our thoughts (probably, symbolic for the most part), before these are translated into our mother tongue.

Eric Drexler (1955)

In "Diamond Age", a science fiction book set in a future dominated by nanotechnologies, Eric Drexler is a world hero. It's not by accident. Drexler was born in 1955, in California, and he has perhaps been the most active scientist in the investigation and promotion of the studies and the development of nanotechnologies over the last two decades. During the Seventies, he undertook his cultural and scientific formation at MIT; his first interest was directed to the study of possible extraterrestrial expansions of human life. It is in the late Seventies that he elaborated the idea of molecular nanotechnology; in fact, the year 1979 was marked by his encounter with Richard Feynman's pioneering 1959 speech "There's Plenty of Room at the Bottom". It was love at first sight: it was the beginning of the path along which Drexler's studies and interests have developed thenceforth. It took him seven years to collect his reflections on a future still technologically distant, but conceptually already within reach into his first original work: "Engines of Creation" was published in 1986 and it brought about a small revolution. It was Marvin Minsky, who at MIT had been the supervisor of Drexler's Ph.D thesis in molecular nanotechnology (obviously, the first one in history) to write in the foreword that the book "offers no mere neutral catalog of possibilities, but a multitude of ideas and proposals for how one might start to evaluate them". These are the ideas generated over years of reflection on the impact that such a powerful technology might have on our life, our health, our economy and our conception of the world; the underlying conviction is that when nanotechnologies become a reality, our whole world will undergo an unprecedented transformation. The difference between a sick cell and a healthy cell or between the despised coal and the precious diamond is but a difference in atoms: ever since the Stone Age, our technology has been moulded to deal with and move quantities of atoms, at first roughly and then in a gradually more sophisticated manner. Imagine what would be our power of intervention on the world if we were able to directly manage reality atom by atom. Here lies the essence of the philosophy and the importance that nanotechnology might acquire. In particular, one of Drexler's ideas foresees to employ specific systems as to make the first nanorobots endowed with the capacity to self-replicate quickly and autonomously: if a molecular robot can do little for you as it can only move portions of infinitesimal matter, in contrast, a self-generating army can do a lot, in a short time and, not secondarily, leading to a significant drop in costs. Just to mention one among Drexler's numerous projects, it might be possible to replace present computers, built upon electricity and semiconductors, with very high-speed mechanical machines, a zillion minuscule and super fast switches and levers functioning better than Charles Babbage could have ever imagined. In 1986, Drexler and his wife founded the *Foresight Institute*, a non-profit organization with the goal of spreading information concerning nanotechnologies as to prepare their advent.

23. We Know and We Do Not Know

In the first place, we know that this book would not have come to light without our daughter, it is dedicated to her, and the first acknowledgement goes to her. Marta made her important contribution both directly (helping us with the footnotes, the biographies and the various re-readings) and indirectly (through her energy, her intelligence, her affection and… her measured distance). We are well aware that having us as parents is far from an easy journey, probably it implies several advantages (affective, economic, cultural) as well as numerous risks (weakness, boredom, greed, etc…). A child needs to safeguard and develop his independence and freedom without incurring in serious mistakes. In all probabilities, it has never been a simple task, but today it is certainly a very arduous one. Therefore, by extension, this book is primarily dedicated to the parents and children of our present society. We can testify that the scheme "first truth, then love and finally enjoyment" is an extremely functional pattern. If our path as divulgers is bound to continue, we will certainly devote a considerable amount of time to this topic.

Our second acknowledgement again finds its source in Marta. In fact, it was thanks to her that we got to know those that would then become our two main assistants in the research area: Jacopo Tagliabue and Luca Leardini. This book is also a bit theirs. Their contribution to the footnotes, biographies as well as to the countless discussions that marked the two-year gestation of this work proved extraordinarily valuable. Jacopo was also efficiently involved in the various phases of coordination and review. It is them and some of their friends we have in mind when we think of those students that are a bit teachers as well: these are outstanding kids, endowed with a brilliant intellect that they are too often forced to hide in order to relate with the rest of the world. Hence, the second dedication of the book is to everyone who has been, or still is, a bit student and a bit teacher as well. No rhetoric here, but merely a mutual interest rationale. The rise of semi-immortality entirely depends on the intelligence of those who, one way or another, "feel" that the goal is approaching and don't want to let it slip away. Both for themselves and for the rest of humanity.

As to the notes of the book, we conclude by thanking Nadia Bianchi and Manuela Dolzan, brilliant researchers in the fields of physics and biology respectively: without their precious contribution the book would have been much less complete. Finally, we want to express our gratitude to Franco Belluschi for his efficient graphic support and to Nicoletta Re for her valuable organizational work. Thus, the third dedication of the book is, by extension, to all the people who worked with us in the last thirty years. Some of them have played a role of capital importance in our journey, without them we wouldn't have been able to achieve the objectives we did achieve and, not a minor consideration, we would have never been able to write this book. Their names flow in our minds and they know how dear we hold them.

There are a few more things we know. We know that, to this day, we have been very lucky in every aspect of life. When we get up in the morning, we smile: we have managed to create a sort of "ideal territory" that we believe comprises not only economic wellbeing, but also spiritual (whatever this term means) wellbeing and physical wellbeing. We try to share this area with the greatest number of people possible. To date, we can be reasonably sure of not having any enemies and of adhering, rather strictly, to the ethical, aesthetical and social laws that are expressed in this book.

We know that this book represents the culmination of a path that has been long and complicated, but nevertheless succesful in every respect. Just as it is normal, in almost fifty years of life, we have come to explore every nuance of human emotions. Often, we have reckleslly pursued them, often, we have pushed them to the edge to achieve a better understanding of such emotions. Luckily enough, we have managed not to be overwhelmed, in part, thanks to the inner strength we both certainly possess and, to a certain extent, because we are two and not on our own. However, we are convinced that what mainly contributed to make it happen were precisely the "recipes" presented in this book.

Finally, we know that we might as easily die tomorrow. After all, we have always lived our lives embracing a perspective of "clear-headed precariousness", in every respect from love to health and money. Any action or thought that tends to hide, or make us forget such precariousness, ultimately leads to unhappiness, defeat and pulls us closer to death. Living often on the edge fosters the development of this sense of precariousness, prepares us to face any situation in life and progressively makes us happier and happier. Only "precarious" men and women will be able to achieve semi-immortality.

Now, let's turn to what we do not know.

First of all, we do not know whether this book will effectively mark both a point of arrival and a point of departure. Not only due to obvious reasons of random nature... the now classical stroke of lightning, a serious desease, a series of bad investments, the termination of our relationship, an excessive speed in the deterioration of our faculties, or we might be conveniently stopped to prevent our possible manifest "folly" from harming anyone… but also due to considerations concerning the potential impact on the "external world". Recall that the main purpose of our book is to meet travel companions with whom we may share the vision of the game and the related semi-immortaility. At the time being, our strength, although not completely insignificant, is definitely inadequate to allow the goal to be achieved, at least within our desired time frame. Since we are not accustomed to sit and wait, or to be structurally dependent on the work of others, we prefer to engage ourselves directly and personally. This is what we've been doing throughout the past thirty years, this is what we might do over the next thirty. And it is precisely on that "we might do" we intend to focus our attention in the coming years: until we continue to consider semi-immortality as a truly attainable objective we will keep on committing ourselves with all our resources, economic, physical and psychic. Otherwise, no drama here. We are but a simple product of those players that have preceded us, a product with no "intrinsic merit". Several other players are playing at this very moment and so many others will play tomorrow.

In the unlikely event that this book actually produces a real impact on the path towards semi-immortality, the number of things we do not know is large. For instance, we do not know how many people we'll manage to get involved, we do not know what are the projects that we'll be able to accomplish and, perhaps most importantly, we do not know how fast the other players will make their moves.

Furthermore, we don't know whether this book, for the first time in our life, will unfortunately cause some "enemies" to appear. We hope it won't and we will do everything we can to prevent it from happening. From our standpoint, we respect everyone's ideas. Our idea of semi-immortality is not to the benefit of a few and to the detriment of the others. The rules expressed in this book, whether right or wrong, nevertheless apply to any person and, with the necessary transpositions, to any living being, be it animal or plant". We apologize in advance if, for religious or political reasons, anyone should feel offended by our observations. However, the only thing to do for the moment is simply "to switch channel", as they say. Moreover, inasmuch as we are far from sure of being right, we will warmly welcome any other coherent and well-structured proposals that we might ourselves come to in the event of failure.

Finally, and this is the most serious concern, we do not know whether we are actually ready. Taking as a fact that there exist several signs, we do not know if we have interpreted any of them correctly. Taking as a fact that there exists a preparatory path, we do not know if we have really come to its completion. Taking as a fact that there exist both an internal force and an external one, we do not know whether we have actually achieved them.

Nevertheless, thirty years have elapsed and the first great circle has been closed.

23.1 www.ilabs.it

As it is natural to expect, the book "continues" online at **www.ilabs.it**. Everyone will be able to leave comments, have a direct contact with us, propose ideas and, if desired, engage in the attempt to directly participate to the Solution to the Game.

24. Finale

Here it is, the first Great Circle finally closed.

If our luck continues to be good, in thirty years our outstanding adventure will still be alive. And if our luck is extremely good, other thirty years will follow and then other thirty, endlessly.

The path we have taken, in the end, is aimed at letting this marvelous game last forever.

Two players get together, the game is on. Matches are played day after day, with flexible rules that evolve along with thoughts, values, love. A love for everything that is done and thought and accomplished. A game initiated with such ease and simplicity. It seemed so obvious and normal to us, although, on the contrary, everyone conveyed the difficulties inherent in our path. Nevertheless, we went ahead continuing to regard it as normal.

This lack of fear is something that has always characterized us and it has been the main drive, or perhaps the instrument, enabling us to push ourselves towards goals often beyond "permitted" boundaries. Perhaps our mutual harmony, our union that has grown more and more stratified as it progressed are what made us so similar, so impenetrable, so exclusive. After thirty years we ask ourselves "have they really passed by?".

Our mind is always new and fresh as it is constantly renewed by intellectual and emotional stimuli. We always enjoy playing and creating new games. Our love is already an immortal act, hence, it doesn't matter if we physically manage to become semi-immortal. We are just fine with being aware that what we have constructed is bound to last for a long time ahead.

Was it all a game of fate? Have we been able to play with fate? Have we complied with fate's laws? We do not know the answers to these questions, but there is however a meaning in all this: perhaps we have been able to grasp the essence of our destiny and today with our maturity we are realizing its interpretation.

Certainly, the game is not untroublesome, and it is not for everyone, but still, we wish to give it in all its facets as a gift to whoever wants to accept it. This book is the recipe book collecting all the ingredients we believe may bring us closer to happiness and therefore to semi-immortality.

This is who we are, this is the Game we propose …

Will we uncover someday all the laws governing the universe? Will we be able to describe the functioning of complex systems, such as the human brain? The authors argue that all the necessary tools for these achievements will be soon available: if humans alone cannot accomplish the task, artificial minds will help us completing the project.

The integration between genetics, nanotechnology, artificial intelligence and psychoneurophysology will not just improve our knowledge of the body, but also help us developing strategies to fight aging.

Singularity is near: we are at the edge of an unprecedented change, the dawn of a completely new era. The exponential development in technology and science is getting us closer and closer: the book aims to popularize the main discoveries that drive this process and the results of thirty years of multidisciplinary research made by iLabs.

It is crucial in this perspective to appreciate that science and technology are not by themselves sufficient: to finally attain the goal we need a coherent view of our existence as individuals and societies. Attaining Semi-Immortality will require massive changes in the way we understand morality, justice, economy and any other part of our eveyday life.

Antonella Canonico (1961)
Director of iLabs Psychoneurophysiology Department

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