EPJ Web of Conferences **366**, 01001 (2026) https://doi.org/10.1051/epjconf/202636601001
10th Complexity-Disorder Days 2025

Introduction to the Proceedings of the 10th "Complexity-disorder" meeting– Mind, an example of complexity and disorder

Jean-Claude Serge Lévy

MPQ, UPC, CNRS UMR 7162, 10 St. A. Domon and L. Duquet, 75013 Paris, France

Abstract. Mind is an essential part of human activity and the result of a biological object: brain and its neural environment in front of the external nature. Considering both conscious and unconscious activity of mind facing the world during the circadian activity, the analysis reveals a first level of complexity and disorder for humans as well as for animals: the internal image of the complexity and disorder of the external world in the unconscious mind. At the next level, life in tribes or in society interplays different individual minds and such an interference brings a new level of complexity and disorder as observed at worldwide scale. So, which is the reason for society's stabilization, when it occurs, while divergent minds compete together. The answer arises from the interplay between practical order and external order such as religion. Specific architectures keep the track of this stabilization. This weak societal dynamic equilibrium is strongly perturbed by historical evolution and by the development of successive historical eras. The present high level of technicity means that the future must be in a higher level of complexity and disorder than ever before. Finally, the contributions are introduced.

1 Introduction

Mind is a central part of human or animal activity. Mind results from a complex process linking brain and other neural centres facing internal and external reality. At a higher-level of activity within a group, mind leads to the building or unbuilding of human and animal societies according to processes which are relevant of human or societal sciences. Such powerful behaviours governed by minds can be easily compared to physical or chemical processes of cluster aggregation or disintegration, i.e. evolution, at least from their structural results. In other words, mind is really at the centre of many pluridisciplinary effects.

There are other interests and approaches in the study of mind. Mind is easily observable both in animal or human behaviour and as a biological object with all the present lab tools. And as a central part of human and animal activity, the powerful mind suggests its biomimetic use for building efficient AI, artificial intelligence, a real current challenge with, for instance, the hope for a clever robot at work for a pure mind.

Of course, here we just want to give an overlook, a global view of such mind processes involved for instance in building or unbuilding societies. This useful restriction avoids considering a full variety of events and to be overcome by so many details. A similar long-distance observational effect is already used in "global history" or "world history" [1-3] with the same goal of a resulting simple schematic view of main effects, forgetting the numerous details of a complete history.

Mind results from the progressive understanding of our inside and of the outside world during life. So, this essential picture evolves during individual life while learning step by step on both sides, self and outside. This complex mind structure is observed from individual behaviour [4] as well as from biological analysis [5,6]. So, a first part of this study deals with the understanding of the complexity and disorder of our individual mind facing the influence of reality. Of course, this simple analysis of mind complexity works for animals [7] as well as for human beings.

The second part of this study deals with the competitive interactions of individual minds within a pack, a group, a tribe, a society. Here too, a huge lot of historical observations are available [8-10], from both history and anthropology, when considering primitive or old societies with different techniques. Here, always in a synthetic approach, there is just to use these well-known works to obtain a realistic view since the observation of the stability or instability of human societies has been well established from a long time.

The next part of this mind study consists in taking account of the main results of global or world history, i.e. the existence of 3 distinct successive eras in human history: hunting-gathering, farming livestock herding and industrial era, while we are now entering in a post-industrial era. As usual in the physics of critical phenomena [11] such strong changes must induce phase

transitions or emergences of new phenomena such as criticality, at all levels. Of course, in this case, this is the bonding of human societies, the very nature of their linking together changing during these successive transitions. At the level of individual mind, these transitions induce also deep changes. And the future of these links, i.e. of our societies, is not easy to predict.
Finally, the contributions to these proceedings are introduced.

2 Complexity and disorder of animal and human mind

The complexity and disorder of mind comes both from the outside world as well as from its own internal nature which are linked together in strong relation by necessity. And this strong relation between mind and outside world evolves with time and learning steps for a single individual as well as it evolved with the different eras of human societies.
A main feature of life on earth is the circadian rhythm [12] with its weak variations with the seasons and its strong permanence. During day, at least for diurnal animals, mind is busy with numerous actions which consist in observing the environment, playing with it, looking for food, and finally eating. Of course, this full activity requires a large energy consumption at the brain level. During night, quite less neural activity is required, just maintaining the basic vital activity during rest and looking at digestion. This night behaviour means finally a deep energy saving at the brain level, while thinking about the goals to be achieved on the next days.
This energy saving corresponds to a strong change in the level of neural activity during night, i.e. in a strong shift of most of the threshold levels of neural activity between day and night. Numerous available observations about neural activity during the night show different sleep phases including dreams, and different phases of propagation of electric waves through the brain. A synthetic view of all these processes is not easy to find in such a complex brain environment and needs a distinction between conscious and unconscious processes.

2.1 Conscious and unconscious mind

A very basic point in this analysis consists in parting the conscious part of mind from the unconscious one. In the conscious part of mind many neural contributions interfere with an integrated, consistent result, while in the unconscious part less numerous neural contributions interfere with a more “local” result, a very restricted view. This is Libet’s famous result [13] as early noticed by Delacour [14] as clear biological evidence of Freudian observation [4]. More precisely Libet observed that the conscious neural activity requires a time of about 0.5s, while simple neural activity takes a quite shorter time, typically 0.1s.
This large time difference between the two behaviours comes from the numerous connections involved within a conscious activity and especially the inhibitive ones which are quite slower to establish than the direct ones, while for the unconscious mind just a few connections are active. This time difference is an essential difference between conscious and unconscious thinking.
Because of that observed point the conscious mind works rather slowly, and this slowness can deal efficiently in fitting with the full complexity and disorder of the real world. But the unconscious mind is quite different from its conscious counterpart.
From one given time to another one, this is not the same unconscious mind which works, but quite different sets of a few activated neurons at each time, because of energy saving during night. In other words, the global unconscious mind which results from the sum of all these possible instantaneous unconscious minds has a full complexity and disorder which gives to the animal or to the human being an incomparable richness, an incomparable complexity which makes the difference with the conscious mind, which is more rational. In one word, the conscious mind is rather sure, while the unconscious mind is rich and full of fantasy, of creativity, but also of risk.

2.1.1 Application to conscious and unconscious AI

There is a direct translation of the process of conscious and unconscious mind into conscious and unconscious AI just by selecting few sets of neurons for unconscious AI. Practically it consists in a frequent random change of the neural thresholds during rest time to strongly restrict the number of efficient neurons at a given time, i.e. to obtain an instantaneous unconscious state. Such a regular change during rest time involves electric waves in the brain which are alpha, delta, theta, beta waves. Such similar changes in AI would enable to save “brain” energy in a regular way, without black spots and so, to obtain many instantaneous unconscious states.
At a given time during rest, a very restricted set of effective neurons is active: this is the instantaneous unconscious mind. Such a process defines the whole unconscious mind as the result of the superposition of all possible instantaneous unconscious minds. Of course, as noticed before, there is a lot of fantasy, of uncertainty, of contradiction in such an unconscious mind. This diversity is interesting but also dangerous since errors can occur. What is more interesting for AI is the conscious mind [4] with its personal view from a self. And different personal conscious minds can interfere together to obtain a more consensual extended view. So, a more accurate observation of unconscious mind is required before looking at conscious mind, as well as in AI.

2.1.2 The unconscious mind

Psychoanalysis has been studying the unconscious mind for a long time [4]. Dreams, the fascinating part of the unconscious mind, are hard to interpret because of their use of metaphors and approximations which just correspond to the low number of synaptic connections available at a given time and so to necessary approximations when dreams are built. Surrealism, a famous art branch, even used a process clearly referring

to the unconscious mind to create a new process for writing poetic, "automatic writing" [15], which is full of incoherence, "a tale full of sound and fury" in Shakespeare's words [16]. The result of this unconscious mind activity is also such a large freedom, a real poetry, since this language cannot be easily understood and remains fascinating with its secrets, its unexpected connections.

More generally this instantaneous unconscious mind means a strong creativity because of this lack of inhibition. And this creativity remains a powerful tool with many applications in science as well as in art.

Another interesting property of the whole unconscious mind, considered this time, i.e. observed on large time scales, is its extraordinary richness, since many details are stored in it without any check of their validity and truth by means of conscious effort. In the literature, there are numerous famous historical examples of this special extended unconscious memory.

2.1.3 A few evidence of the unconscious mind activity

A first classical example of the unconscious mind activity comes from Plato's report in "Meno" of the dialogue between Socrates and a young slave [17] about mathematics. Finally, Socrates shows that the young slave demonstrates by himself the Pythagorean theorem, in the simple case of an isosceles rectangular triangle. The underlying explanation of this mathematical success by exegetes is the "latent memory" of the young slave, a memory which would have been printed in his unconscious mind even before his birth as a common sense. The effective probability that such an event occurs is weak, but not strictly zero.

Another classic example, also about the analysis of teaching and learning processes, is reported by Piaget [18], a famous expert in the teaching and learning analysis. And his explanation of pupil behaviour also involves a deep memory effect, linked to some unconscious mind. Piaget found many examples of pupil's mistakes which he recognized to be the result of old, archaic beliefs which suddenly reappeared in the pupil's mind from time to time. Here too, the probability of such an occurrence of the memory of such a removed past, sounds to be weak but not completely null because of the extension of the unconscious mind.

For these two cases, it seems to have evidence of very extended memory which can be linked with the properties of a whole unconscious mind.

Now, there are two following examples of the wonderful power of images which seems also to come from our deep unconscious mind and to interfere with a serious conscious development of the author's mind. These images are the two famous allegories of Plato's book "The Republic" [19].

The first allegory, the most known, the allegory of the cave, tells us that we do not see the real world but just an image of the real world projected inside the cave, instead of seeing the direct real world. And as a matter of fact, this is not an allegory, this is just the true reality. This is exactly the case of our mind which integrates all our observations of the external and internal world in our whole unconscious mind, with the well-known Freudian classification, id, self and superego [4] just to act. So, our mind is just our cave wall. And pleasantly enough, our brain shape looks like a cave wall.

Of course, mind needs an internal representation to optimize its concrete activity. And this individual representation changes with experience and learning according to our evolution during our individual life. This introduces relativism in our observation.

The second allegory of Plato's "The Republic" [19], less famous than the previous one because of its eugenic meaning, mixes in a stadium a few hundreds of nude clever and smart girls and boys who stay together during a long time enough to produce a new generation. Except for the clothes and the special location, this situation was nearly the reality at that time for Athenian citizens. In Athens, at that time of slavery, young citizens had nearly nothing else to do than to think, to learn and to think of the future, nearly the goals to be achieved in this stadium! Here too, this conscious allegory sounds to be just an unconscious translation of the current reality of that time. Once more unconscious mind acts as a creative part of this allegory.

2.1.4 A few cases of societal stability

It's hard not to comment this strange historical point of Athenian society. The observational status of the high level of freedom of Athenians has not been stabilizing the Athenian society for a very long time, just during its famous" Golden Age", i.e. during less than one full century. This relative short time means that this high level of thinking was not followed by concrete actions in the building of a permanent society.

By contrast, in the next Roman civilization, young and old citizens were strongly involved in numerous practical tasks such as farming, building roads and structuring the whole earth space, with a resulting exceptional long-time stabilization of Roman era because of these concrete realizations over several centuries.

After these few examples of the thinking activities of unconscious minds, and of the stability of civilizations, comes the very serious question of the collective management of a set of unconscious minds. Such a mixing of bright individuals brings a new level of complexity and disorder to the already singular complexity of unconscious minds. So, it brings a strong risk of instability. This is the subject of the next chapter.

3 A set of unconscious minds

Within nature, a single individual, animal or human is rather weak in front of adversity. For surviving he needs collaboration with several partners, within a pack, a tribe, a set or a society. There is a large observation of such a clustering phenomenon for animals as well as for humans, at different levels. But such a collaboration leads also to develop antagonisms between independent free unconscious minds. In other words, the long-time stabilization of such heterogeneous clusters is far from

being obvious as already discussed about the social history of Greeks and Romans.
Here too, there is a large observation of this attraction-repulsion phenomenon, nearly a physical question, and of its consequences, from biology [20], anthropology [10] and history [21]. So, numerous and serious synthetic views of this difficult but frequent problem merge from our history. These views give keys for this difficult stabilization process which, of course, changes with societal experience.

3.1 Societal stability

One of the main questions about that collaboration between individuals remains to be the duration of the stability time of these societal entities as already observed before about the compared stability of Athenian and Roman societies. This was a real challenge for historians to understand the basic stabilizing mechanism of a society. And experts in exotic societies [8, 9] found as a result from a very large observation that the right balance between a terrestrial power, the chief's power, and a supernatural power, the power of religious feeling, was responsible for the long-term stabilization of human societies. As a matter of fact, these religious feelings take quite different shapes according to local societies and their environments.
For primitive human societies, the religious feelings which stabilized their societies were polytheist or animist ones. This feature looks well in accordance with the multiform nature of our unconscious mind and of the id. The translation from polytheist culture to a monotheist one, as it appeared often, occurred later, probably under the influence of chief's power, to reinforce the unity of the tribe. But this first step of polytheism remained active in minds and was not forgotten in later societies.

3.1.1 Societal reminiscences of Polytheism

The issue of this fight of ideas between polytheism and monotheism was not so clear with, for instance, the emergence of Trinity or of Saints within monotheist religions, a memory of the primitive polytheism and its abundance of gods.
Another evidence of this useful balance of interest between different topics for the occurrence of a stable society is the frequent occurrence of a double power such as both a Senate and a Parliament at the head of a nation. And finally, numerous intermediate levels of power such as laws and competitive laws occur in a stable society, as another image of primitive polytheism and diversity.
Modern democracies show the difficult balance between so many tensions, as an ultimate proof of this divergence of interests, with the appearance of quite numerous conflicts of different sizes and durations. This is the first global evidence of the evolution of the deep unconscious mind through the whole human history. And these changes have been very strong during this evolution.
Another reminiscence of polytheism and its complex view comes from the modern quantum physics [22, 23]. The interpretation of the probabilistic nature of reality in quantum physics leads to multiple present interpretations, in parallel with the very nature of primitive polytheism! This interplay between the unity and large numbers is quite general.

4 Evolution of the unconscious mind with human eras

Since the unconscious mind results from the exchange between man and its environment, the unconscious mind changes also with environmental variations. And during the few transitions between the different human eras, the environmental transitions were strong and numerous. So, the unconscious mind, taken himself as a whole, strongly changed during history.
The track of the unconscious mind well appears in art, as already noticed about the case of Surrealism. Art results from our deep inside, in other words from our deep unconscious frame, with less conscious control than standard conscious communication. And the success of art among people is due to the basic agreement and internal resonance of other unconscious minds with that single view. This concordance means its deep relevance. This defines a simple way of observation of the changes of art, i.e. of the collective unconscious mind through the different human eras, as a simple criterion of this internal evolution. In other words, we are led to revisit the whole history of art, a whole business.
Of course, the study of such a large frame of the evolution of the unconscious mind would require a complete statistical analysis, a hard task. Here in this simple approach, we will use just a mere feeling from general observations. This can pave the way for future more complete analysis.

4.1 The unconscious mind in art during the hunting gathering era

Of course, this primitive era is not so easily known and new results are coming often with new information which strongly perturbs the previous common feeling. But there are already many tracks of art from this deep past as well as many observations from recent primitive societies. It sounds like it is enough for making our own ideas about it.
A first point to notice is the abundance of artistic remains from this past time. This observation is largely correlated with the common time schedule of human work during this era. Present-day primitive tribes take about three hours a day to find enough food for them for the present day [24], a rather short time. So, these people benefit from a large amount of time to think about their environment, to create ideas and things according to their feelings. And they perform such a personal work with quite interesting results [25]. Such works of art are integrated in what is now called "Art Brut" or "Primitivism" [26] and receives a lot of success in many museums all over the world because of their originality and their deepness.
Generally, the tracks of these old activities are found within natural shelters. That location sounds like an

echo of Plato's cave, a reminiscence of old times! This old observation confirms the continuity of such knowledge through ages. Tools, statues and paintings were found in these numerous shelters which are observed in many places.

4.1.1 Art and unconscious mind in the hunting-gathering era

Tools in stone were first produced [25, 27] probably because of their basic use during hunting as knives and weapons. These objects were carefully realized and often include personal drawings. Tools in bone were also early produced [27]. And among these bone objects, musical instruments such as flutes were also produced in many places. This is another proof of this early character of art and of the early development of an unconscious mind in primitive life, an echo to the sounds of natural life.

Many statues and pieces of jewellery were also found in caves and shelters. Among the statues, many of them show women, "Venus" of many places [25]. This frequent reference seems to be a sign of polytheism with a marking place of motherhood in the primitive unconscious mind. The important place of jewellery in primitive art [25] is also another mark of both technical mastering and a tribute to beauty.

Plenty of wonderful paintings were found on the walls of these caves [25, 28]. They generally show hunted wild animals, in action. These paintings gave particular attention to motion and to speed. The art of these paintings impressed Picasso and many famous painters such as Matisse who took these primitive artists as inspirative models [29], because of their natural strengths and of their use of natural colours. The high-level practice of colours within these paintings testifies their clever early research of specific materials. Sometimes hands with some cut fingers are shown [30]. This successful challenge is a concrete proof of a real mastering of different painting techniques.

As a result of the present knowledge, it appears that at this early time, people and art were focused on wildlife and motherhood. Curiously there is no evidence for fruits and vegetables among the already known observations. Maybe it can appear in further analysis. For the time being, the unconscious mind at this era seems to be full of motion, wildlife, motherhood and practical experience.

4.2 The unconscious mind at agriculture and farming era

The great change which happened with this new era was the human settlement. As a matter of fact agriculture requires permanency to obtain the results of a long local work after first ploughing and sowing to finally harvesting [31]. The immediate result of that new permanent state was the building of houses with hard materials.

So, a new art of rigid architecture appeared in many countries everywhere in the world. Moreover, agriculture needs storage of the harvest results for later times in barns, as well as other buildings for the convenience of farm animals. This agriculture also needs many tools and well fitted tools, sellers and so on. The excess food production must be sold. This induces trade which requires connection with other communities. So, step by step, the requirement of a full village and then, of a set of interconnected villages, of some later urbanization with convenient schemes appeared all over the cultivated world. For the conscious and the unconscious mind as well, it was a completely new way of thinking with new priorities linked with farming.

4.2.1 The search for highest buildings

On the other hand, the development of the art of architecture led to the introduction of some pure artistic challenges such as building highest references. Such results proved their real technical mastering. Curiously enough rather simultaneously in Egypt and in Peru people built high pyramids more than 5000 years ago. Later, in both countries and around, higher pyramids were built. The explanation for their common choice of the pyramid shape is its physical stability. But the building of full pyramids requires a lot of materials! Obviously, the building of such large and high pyramids was proof of their high technical level, power and richness. And as a result, a lot of pyramids appeared through the world as a mark of power.

Among new built shapes, many towers such as the lighthouse of Alexandria, one of the seven wonders of the world, surveyed the neighbourhood. The buildings of such masterpieces were linked with progress in geometry and mechanics as well as in many techniques as the recent analysis of a low friction process used for building Egyptian pyramids revealed it [32]. Such highly qualified works required the contribution of numerous techniques and technicians who must work together and exchange with other specialists. So, the need for efficiently written documents for such extended cooperation between many specialists was obvious. And different writings appeared in many countries all over the world.

4.2.2 The invention of writing

The first step used in writing consisted of images which were codified. Such a starting point happened in many countries, in China as well as in Peru or in Mesopotamia with just a few signs at the very beginning. Then the progressive extension of the glossary required successive improvements and generally a change towards phonetic translation with sounds or letters to avoid too large lists of signs.

Such writing processes started very early in China, in America with the Maya writing and in Middle East, in Mesopotamia and in Egypt. The intensity of the exchange and competition in the Middle East, because of their numerous competitive successful agricultures, resulted in an early conversion to an alphabetic writing which was easier to learn and to practice by common people [33].

At the beginning of ideograms, writing was an art, like painting, and as a very specific art, it was restricted to

just a few educated people, the scribes. The introduction of alphabetic versions enabled the extension of reading and writing literature to many people in many countries. This new extended memory and its permanent trace was also a revolution for the conscious and unconscious minds which were open to so many real or imaginary stories, legends. So, literature was also born.

4.2.3 The evolution of religions

As already mentioned before, religion is a natural cement of societies. Such an activity requires regular common meetings. So, religious architecture appeared early everywhere, with large temples and related buildings, as well as writings, drawings, paintings and statues. So, the first point to elucidate is the various evolution of religions in space and time before studying the arts linked with religions and the related development of the conscious and unconscious mind.

At the beginning of this new era each set of people had its own polytheism with many gods which appeared locally according to the details of the local farming history. Later came monotheisms such as Judaism, Christianity and Islam which corresponded to a closer relation of religion with the central power, sometimes in agreement with it and sometimes in conflict with it, always as a basis for society.

The success of Christianity all over Europe and Middle East at the end of the Roman Empire gave it a power of a very special nature because of its so large expansion. Such a huge extension led to the beginning of schisms between different versions of Christianity. Moreover, the successive invasions of Europe by people coming from the Eastern parts, and the emergence of Islam generated numerous developments of aggressivity and conflicts such as crusades with their positive societal counterparts such as trade and exchange development for the shores of the Mediterranean Sea.

The result of this long, diverse and intense activity was both the development of religion, and a general feeling of fear. Religion and fear reinforce each other. So, practically a simultaneous network of churches and castles appeared everywhere with many artistic skills and an imprinted unconscious mind.

4.2.4 The evolution of architecture during the agricultural era

Here too, the competition for a largest scale always occurred everywhere and according to the skills of architects. Very early these temples were decorated with drawings, paintings and statues which included not only animals but also a symbolic representation of plants, a new signature of the large part of agriculture during this era. While the architectural style of Egyptian temples is strong and rather rough, with some memory of primitive caves and hieroglyphs, the styles of Greek temples are varied: Doric, Ionic and Corinthian, with a net influence of plants in its decoration [34]. With these different styles the competition and emulation between the different places to exhibit singularities in these references to farming was quite strong.

In the Roman empire this competition for newness went on with the research of new shapes such as that of Roman Pantheon or of the Saint Sophia Basilica in Istanbul. These massive constructions were obviously reminiscent of natural spherical caves of the previous era as already noticed. These new shapes probably resulted from an experimental optimization of stability after numerous trials at a lower scale. The resulting semicircular vault was later successfully applied to numerous common cases, such as houses, bridges and later to Romanesque churches in many countries [35].

One of the more striking limitations of Romanesque architecture was the building height as observed from the destruction of numerous temples after earthquakes or tempests. As a matter of fact, a partly circular shape is optimal as observed from experiment as well as from modelling [36]. Thus, the use of arches instead of the former full semicircular vaults enabled the architects to reach higher levels, with the help of external buttresses and finally less matter. This was the success of Gothic churches which look like plants under wind. The final heights reached by these gothic churches are comparable to the height of the highest pyramids with quite less materials.

In parallel with this Gothic transition, other models of churches occurred with other external models coming from other parts of the world which happened to be in contact because of mixed aggressivity and trade. For instance, the model of bulbs which has an obvious vegetal origin was largely used in mosques and later in churches with some exotic touch (Basilica San Marco in Venice, Saint Front Cathedral in the city of Périgueux) [35]. These original structures were the successful result of many artistic collaborations which occurred on a large scale, out of strictly religious considerations! In other words, the numerous exchanges and connections deeply changed the unconscious minds according to ways which were unexpected.

4.2.5 The final evolution of the agricultural era and its consequences on unconscious mind

The numerous exchanges which appeared led to a new intellectual dynamism marked by a real taste for experimentation. This led in Art to Renaissance in Italy [37] and to the starting point of printing in France and Germany as well as a new development of navigation in Portugal [38] which led to the discovery of the “New World”. The result of this enormous transition was long to be reached, it lasted during several centuries, but it was a complete societal change towards a modern industrial era.

Once more referring to our usual artistic test of the unconscious mind, this evolution was the starting point of the “Spain’s Siglo de Oro”, a complete renewal of literature and theatre introducing human freedom at different levels [1,2]. This success triggered later events in Europe such as the “age of Enlightenment” which ended this transition phase.

With printing, ideas propagated easily everywhere. A new extended society appeared everywhere with a complete renewal of sciences which also started from experimental disciplines and reached mathematics

because the newness of observations forced new theoretical developments [39].
A very important practical step was the mastering of energy by means of the steam engine. This introduced the industrial era with mining and factories, first with textile industry and soon with trains and fast travels. The social changes induced by the industrial revolution, such as the appearance of a middle class, introduced also deep societal changes and among them the essential role of banking in the industrial development.
A new life appeared for a very large amount of people. And this change was reflected in arts, the social observer of the unconscious mind. For instance, the new role of money as active in everyday life was noticed by economists [40], as well as by writers such as Honoré de Balzac [41] or Jane Austen [42]. Conversely labour unions were created to face the difficulties generated by this new society. New economists and philosophers observed this new way of life [43]. For the unconscious mind, these numerous changes opened new ways of thinking and largely enriched its complexity.

4.3 The unconscious mind in the industrial era

This new emerging society was largely studied by historians and sociologists [44, 45] who noticed the appearance of new forms of arts as well as the occurrence of new activities which, as before, help us in observing the evolution of the unconscious mind.
About arts, a first point to notice is the emergence of new musical forms and new locations for concerts, a powerful index of this change. Sociologists [46] observed that the new middle class which appeared in the industrial era enjoyed music, and so enabled musicians to be freed of previous patronage funding and allowed them to be just paid on performing in large concert halls. So, both many symphonies and operas were created simultaneously with corresponding great enough buildings for receiving such large audiences. This new artistic way started early with the beginning of the industrial era in many places.
A similar change occurred before in painting during the "Dutch Golden Age" with the interest of this emerging new society for enriching its own memory, as well as for their decorative still lives [2, 47]. Later, the artistic interest in steam engines of the industrial era well appeared for "Turner and the Impressionists", with these new clouds of artificial smoke which developed in painting the link between optics and art [48], on the topics, as well as on the observation.
Of course, architecture followed this path of industrial innovation with Art Nouveau or Jugendstil and later Art Deco which took advantage of the new technical mastering and introduced references to nature and geometry [49], i.e. to a memory of the old times. The classical competition for highest buildings took a renewed place with industrial innovation.
As already mentioned, art reveals some parts of the unconscious mind. Here the numerous references of the new architecture to nature revealed this weakness of the new society: the new distance with nature which was so close before in everyday life and which became so far within the industrial era. The emergence of different new leisure activities tried to overcome this new distance and finally lack, in introducing another way back to nature.
Firstly, sport was introduced as a new leisure activity with the creation of numerous games such as races, football, rugby or athletics with a lot of local variations. Quite obviously, it was done to balance the lack of physical activity during this new era, with some mimics of previous standard natural actions. Similarly, allotment gardens appeared, here also with a practical interest for the results of this old activity. Stays along the beaches or in mountains appeared simultaneously as well as hiking and trekking as recently allowed by the occurrence of trains. And finally, these numerous actions introduced touristic economic activities [2, 44] well in tune with the industrial era and its economic development. In other words, nostalgy and progress worked together.
These numerous new activities pointed to a deep perturbation of the unconscious mind. Of course, this new state of mind was observed both by individuals and by doctors in medicine. That introduced psychoanalysis, a new medical science concerned with the unconscious mind and its numerous new problems [4].

4.4 The unconscious mind in the post-industrial era

The first points to be considered are, as in the previous section, the regressed activities at this new era, i.e. the induced lack of action. Then the new activities, which balance the lost ones must be introduced. And finally, the conclusions regarding the global unconscious mind are deduced.

4.4.1 The regressed activities in the post-industrial era

Due to technical improvements such as powerful tractors, or the use of chemical products, and other numerous optimizations such as trade globalization, the number of people involved in agriculture decreased down to just a few percents of the active part of the population.
Quite similarly the number of people involved in industry decreased strongly because of technical improvements such as robotization and numerous optimizations such as trade globalization.
These two main activities of the past became rather marginal, nearly at the same level as many common activities such as service activity or tourism. For involved people, it means a deep change which requires adaptation, firstly at the economic level and later at the individual level, as well as in the unconscious mind to balance this deep lack.

4.4.2 The new activities in the post-industrial era

There are many new activities, and their fast obsolescence occurs soon after their first appearance. For instance, there have been photographs, later movies, and now television and videos. Now these whole

activities can be done now just on a very small smartphone which is also a cell phone, a computer and so on. For individuals such fast changes of activities also mean changes in employment, and numerous changes of work during life. This generates a general instability which occurs even at national level.
As often observed before about the new activities of the previous era, some new activities consist in mimics of the main activities of the previous era, i.e. the industrial era. For instance, there are many activities linked with the practice of skill such as golf, pétanque or darts which correspond to past industrial work in factories. There are also many strategic games such as playing games, or escape games which are close to the past use of management of industrial activities.
A little bit different new activity is sport now conceived as a show, as an entertainment, mimicking the competitivity of industrial era as Roman people mimicked war activity in the arena show with gladiator games. The popular success of modern Olympic games is a proof of this effective translation of old activities into modern entertainment.
A lot of humoristic entertainments try to give a critical look at the recently introduced activities. In this era of multiple changes, such shows give the opportunity to take a distance with reality to understand it or at least to be used to deal with it. This process enables integration within our unconscious mind.

4.4.3 The difficulties of the post-industrial era

While after the Second World War there was a long cold war and a few localized wars, recently with the attack of Ukraine, the risk of an extended war considerably increased. The level of instability between countries considerably increased. More recently the crisis with Iran added another layer to this instability. For the unconscious mind it is a hard task to deal with such instabilities.

5 Introduction of the contributions

The general point of these contributions is that they all play on different grounds as expected with pluridisciplinary works. Pluridisciplinarity becomes a common goal. The first paper is given by Herve Zwirn and deals with a classical quantum mechanics problem, the observation. The conclusion of his serious development, the relativity of any observation, has a deep philosophical meaning.

The second paper is given by Carsten Henkel. This author studies the physical nature of sound as well as its biological analysis. So doing he understands the full complexity of sound with reference to the deep physical levels of sound and music and its common biological observation. Physics and art are interlinked.
Eric Bringuier deals with a difficult problem at the boundary between quantum physics and engineering: the potential realization of quantum computers. For that he looks at a way which can avoid the quantum decoherence which is due to unavoidable thermal fluctuations.
The Hung Diep and Van-Thanh Ngo make a review of the basic question of phase transitions about the problem of the validity of the hyperscaling relation in dimension $d<4$. This interesting review is based on a careful numerical analysis of a very large number of data compared with theoretical assumptions. It reveals a marge number of cases where this hypothetic hyperscaling relation is not fulfilled. And these special cases are carefully investigated.
Igor Shepelevitch and Denis Sabirov investigate the mathematical properties of some chemical compounds such as fullerenes, oxygen allotropes, and aromatic hydrocarbon radicals by considering their Shannon entropy to obtain symmetrical structures. This careful study enables them to classify many new structures.
Alexandre G. de Brevern deals with the interesting biological problem of the complex structure of proteins. Proteins are long molecules made of numerous blocks. Some parts of these proteins are known to be flexible and even mobile under some conditions. So, the model developed here provides a unified description of structural dynamics, bridging the gap between ordered and disordered states of proteins.
The next step of this volume consists in two twin papers devoted to a quite general view of biological units together with a mathematical approach of its full complexity and disorder. The first paper, written by V. Thomas-Vaslin and D. Pastor, derives from biological considerations as well as from mathematical and philosophical ones, the Generic Sensor-Actuator (GenSA) process which is found to be basic for all living systems in front of external complexity and disorder with a kind of homeostasis at least for intermediate time durations. The second paper written by D. Pastor, J. Fernandez and V. Thomas-Vaslin develops the full mathematical theory of GenSA as an automaton theory. The set of these two papers develops a whole theory of living systems.
The two next papers deal with neurons and neural properties by means of numerical modelling and critical experimental observation. P. Monceau, S. Metens and S. Bottani present numerical computations about the experimentally observed activity behaviour of 2D mice neuronal cultures as the coupling between neurons varies. The authors use the adaptive integrate and fire model suggested by R. Brette and W. Gerstner where the concentration in calcium ions plays a central part in neural activity. As [Ca2+] in the medium increases, a transition between independent oscillators towards synchronized ones occurs. And they observe the complex details of this transition. Laurent Goffart who is an expert in experimental observation of neural activity of monkeys, ask here the question of the validity of the observation of “number” neurons in the parietal cortex of macaque monkeys. Here he reveals the shortcomings of these studies conducted with monkeys and reports results that challenge an involvement of their parietal cortex in numerical competence.
In his paper Damien Schoëvaërt-Brossault considers the puppet gesture, a very old art mixing reality and dream

and thus introducing a large complexity in the mind activity. This still active art is also a pleasant teaching experience which reveals mind possibilities for observers.

Finally, Jean-Louis Brousse introduces us to the full complexity of technical engineering. The renovation of the French road network which was a necessity after the second world war led the state to introduce a fruitful analysis of road constraints as well as to develop a concrete new road network. This basic knowledge was recognized at a world level and led to practical realizations everywhere with the advantage of so-trained experimental techniques.

6 Conclusion and Acknowledgements

This volume of Proceedings of the "Complexity-disorder" meeting, as well as the preceding ones [50, 51, 52] contains papers involved in other disciplines than Physics. This mixing process is the very advantage of pluridisciplinary exchanges where similar concepts are developed in different contexts, as early proposed by Phil W. Anderson [53]. Such concrete examples reveal different levels of complexity and disorder and induce comparisons which sound to be useful.

Finally as organizer of this meeting, I must say that it is a real pleasure to acknowledge the constant help of Professor Cristiano Ciuti at the head of the Laboratory MPQ (Matériaux et Phénomènes Quantiques) and of Professor Atef Asnacios at the head of the Physics Department of University of Paris Cité. Without their help, such realization cannot occur.

References

1. F. Braudel, La Méditerranée et le Monde Méditerranéen à l'époque de Philippe II, (Armand Colin, Paris, 1949)
2. F. Braudel, Civilization and Capitalism 15th-18th Century, (Berkeley, University of California, 1981)
3. P. Boucheron (sous sa direction) Histoire du Monde au XVe siècle, (Fayard, Paris, 2009)
4. S. Freud, Abrégé de Psychanalyse, (P.U.F., Paris, 1949)
5. K. Popper and J.C. Eccles, The self and its brain: an argument for interactionism, (Springer, 1977)
6. J. Delacour, Conscience et Cerveau, la Nouvelle Frontière des Neurosciences, (De Boeck Supérieur, Paris, 2001)
7. F. Burgat, L'inconscient des animaux, (Seuil, Paris, 2023)
8. G. Dumezil, Entretiens avec Didier Eribon, (Gallimard, Paris, 1987)
9. G. Duby, Le chevalier, la femme et le prêtre, (Hachette, 1981)
10. C. Levi-Strauss, Tristes tropiques, (Plon, 1955)
11. H. E. Stanley, Introduction to phase transitions and critical phenomena, (Oxford Science Publications, 1971)
12. C. Poirel, Circadian rhythms in behaviour and experimental psychopathology, in Rhythmic Aspects of Behavior, (Taylor and Francis, 1982)
13. B. Libet, The neural time factor in conscious and unconscious events, in Ciba Foundation Symposium 174, Experimental and Theoretical Studies of Consciousness, Chichester, Wiley (1993) 123
14. J. Delacour, Biologie de la Conscience (P.U.F. Paris, 1994)
15. A. Breton, Manifestes du Surréalisme, (Pauvert, Paris, 1962)
16. W. Shakespeare, Macbeth (1623)
17. Platon, Menon, (Flammarion, Paris, 1991)
18. J. Piaget, L'explication dans les sciences (Flammarion, Paris, 1970)
19. Platon, La République, (Flammarion, Paris, 2002)
20. G. Chapouthier, L'homme ce singe en mosaïque, (E. Odile Jacob, Paris 2001)
21. M. Scheffer, E.H. van Nes, L. Kemp, T.A. Kohler, T. M. Lenton, C. Xu, The vulnerability of aging states: A survival analysis across premodern societies, P. N. A. S. **120**, e2218834120. (2023)
22. H. Zwirn, The measurement problem in Quantum Mechanics: Convivial solipsism, EPJ WOC **244** 01010 (2020)
23. Y. Pomeau, M. Le Berre, Quantum mechanics: how to use Everett theory practically, EPJ WOC **263** 01010 (2022)
24. P. Clastres, Chronique des Indiens Guayaki, (Terre Humaine, Paris, 1971)
25. R. Joffroy, Musée des Antiquités Nationales Saint-Germain-en-Laye (Ed. Réunion des musées nationaux, Paris 1979)
26. M. Thevoz, L'art brut (Albert Skira, Paris, 1975)
27. I. de la Torre, L. Doyon, A. Benito-Calvo, R. Mora, I. Mwakyoma, J.K. Njau, R. F. Peters, A. Theodoropoulo, F. d'Erico, Nature (2025) https://doi.org/10.1038/s41586-025-08652-5
28. J.-M. Chauvet, E. B. Deschamps, C. Hillaire, J. Clottes, P. Bahn, Dawn of art: the Chauvet cave: the oldest known painting in the world, (H.N. Abrams, New York, 1996)
29. J.L. Andral, Picasso 1945.1949, l'ère du renouveau, (Snoeck, 2009)
30. F. Aton, Finger amputation in prehistoric cave art may have been for religious rituals, new study finds, Art news (2023)
31. I. Khaldun, le livre des exemples, (Gallimard, Paris, 2002)
32. A. Fall, B. Weber, M. Pakpour, N. Lenoir, N. Shahidzadeh, J. Fiscina, C. Wagner, D. Bonn, Sliding friction on wet and dry sand, Phys. Rev. Lett. **112**, 175502 (2014)

33. B. André-Leicknam, C. Ziegler, Naissance de l'écriture, eds. (Ed. de la réunion des musées nationaux, 1982)
34. A. Choisy, Histoire de l'Architecture, Tome 1, (Eds. Vincent, Fréal &Cie, 1964)
35. A. Choisy, Histoire de l'Architecture, Tome 2, (Eds. Vincent, Fréal &Cie, 1964)
36. P. J.-M. Monceau, J.-C. S. Levy, Mono-dimensional effects on elastic and vibrational properties of lacunary networks, Phys. Rev. B **49** 1026 (1994)
37. Pétrarque, Canzoniere (Gallimard, Paris, 1983)
38. C. Markovits, S. Subrahmanyan, Navigation, exploration, colonisation, in [3]
39. D. Wootton, The invention of Science: A new history of the scientific revolution, (London, 2015)
40. A. Smith, an inquiry into the nature and causes of the wealth of nations, London (1776)
41. H. de Balzac, Grandeur et décadence de César Birotteau, (Paris, 1837)
42. J. Austen, Pride and Prejudice, (London, 1813)
43. K. Marx, Das Kapital, (Hamburg, 1867)
44. F. Braudel, Civilization and Capitalism 15th-18th Century, (Berkeley, University of California, 1981)
45. P. Bourdieu, La distinction, (Les éditions de minuit, 1979)
46. P.-M. Menger, De la division du travail musical, Sociologie du travail, **25**, 475 (1983)
47. M. Restellini, L'âge d'or hollandais, (Editions Pinacothèque de Paris, 2009)
48. J. Clay, L'impressionnisme, (Hachette, 1987)
49. A. Sanna, L'art nouveau (Editions Place des victoires, 2009)
50. J.-C. S. Lévy (Ed.), Complexity and disorder meetings 2018-2019-2020, EPJ Web of Conferences **244** (2020)
51. J.-C. S. Lévy (Ed.), 8th Complexity and Disorder Days 2021, EPJ Web of Conferences **263** (2022)
52. J.-C. S. Lévy (Ed.), Complexity and disorder days 2023, EPJ Web of Conferences **300** (2024)
53. P. W. Anderson, More is different, Science, **177**, 393 (1972)