Topography of Complexity

Benoît Virole

2021-2023

Abstract

This text presents, reevaluates, and completes the theses that are developed *in extenso* in the following books: *Cognitive Science and Psychoanalysis* (1995), *The Complexity of the Self* (2011), *In Praise of Autistic Mind* (2015), and in articles that can be viewed at www.benoitvirole.com. Our central thesis is that the recursive investment of narcissism on the primitive self modifies its organization by differentiating a new instance, the self, whose structural dynamics are those of a complex system. Fundamental facts coming from psychoanalysis, anthropology and cognitive sciences can then be understood within the framework of a unified theory.

Introduction

Contrary to an epistemic position consisting in posing a punctuation of closing between the sectors of reality (psychic, cultural, physiological, etc.), we operate a deconstruction of this punctuation by seeking to make intelligible the articulations within a virtual space of greater dimension. For example, psychoanalysis has described the way in which the ego invests (and/or disinvests) objects and enters into conflict with the superego and/or the id. Cognitive neuropsychology describes the cognitive functions involved, for example, in perceptual categorization, decision making, automatic or voluntary behaviors (etc.). Structural anthropology defines the framework in which behaviors are overdetermined by the existence of kinship structures, social organizations, (etc.). These three domains are not separated in reality. But each one is explored from a discipline with its own lexicon, methods and objectives. To reach an intelligibility of the articulations between these domains requires the establishment of a new conceptual framework with its own lexicon.

In other words, it is a question of plunging our object of perspective (a model of the psyche) into a virtual space of larger dimension and to study its deployment. From then on, in this enlarged framework, developmental psychology, psychoanalysis, cognitive sciences, neuropsychology, neurosciences, anthropology operate local sections inside the globality of this virtual space and reach each a sectorial intelligibility. The cognitive sciences propose models of mental functioning (logical, symbolic, informational, self-organizing). Neuropsychology identifies the stable forms of cognitive processing (information processing modules). Neuroscience seeks to describe the physiological implementation of these modules in neuronal structures. Psychoanalysis describes the effects on

the human psyche of the singular status of the sexual drive ("object relations, Oedipus complex, etc."). Anthropology defines the collective structures of a given society. On an epistemological level, all these disciplines seek to define sectors of intelligibility by the deployment of their own theoretical vector. These vectors may overlap on certain sectors and describe them in a distinct way with their own conceptual organization. In happy cases, we see interdisciplinarity, in unhappy cases a sterile confrontation. But none of these disciplines can claim to be universal in their understanding of the psyche. To remain confined in only one sector is an error ("of punctuation") on the epistemological level because the real ignores the disciplinary partitions. The integration of these different vectors is only possible within an approach assuming complexity.

The paradigm of complexity

The only way to progress towards the intelligibility of psychic complexity is therefore to give ourselves a conceptual space as vast as possible. The theory of complex dynamic systems is this virtual space, metaphorical of course, but which offers the advantage of providing us with a new lexicon. A complex dynamical system is a system of n interacting forces, each constituted by several interacting factors whose identity is not known a priori and whose values can change continuously while the parameters of the global system (for example, the mind, the consciousness, the psychic activity...) remain globally constant. This system is manifested by apparent states. It is assumed that there exists inside this system an internal dynamic, also unknown, unobservable, which defines the states that this system can occupy in a stable way. These states are in finite number. They are considered as the attractors of the system. These states virtualize each other. These states do not exist in isolation. They are linked by relationships of reciprocal determination and thus fulfill the conditions of a structural system in the sense of Deleuze. This system is controlled by control factors that vary continuously in a so-called external space, or substrate space of the system in which observable qualities are manifested (e.g., neurophysiological observables, neuro-mediator levels, kinetics of neuromodulators). For certain critical values of these control factors, the system bifurcates towards another attractor (thus another state of the system). This transition of states is manifested by a discontinuity of some of the observable qualities (mental states). In psychopathology, we observe abnormal stabilizations in certain types of states (for example depression), abrupt transitions, sometimes cycles, evolutionary trajectories, anxious or delusional phenomena, etc. We can be satisfied with a relational definition of this type of system which makes it possible to qualitatively foresee its evolution and the structure of equilibrium towards which it tends, in a variable environment including chance and likely to modify it. It is the case of the psyche in interaction with on the one hand the biological reality and on the other hand the social reality, and which is influenced by them, while maintaining a structural stability ("we remain ourselves, in a certain proportion, in spite of the variations of the world and the existence, of our somatic states").

Until now, the complex nature of the psyche could not be described correctly in the absence of a clear understanding of the dynamics of recursive processes and in particular of the phenomenon of self-reference. However, the ground has been prepared. Kohut's model of the self (1971), as well as the work of psychoanalysts re-evaluating narcissism (Grunberger, 1971) (Green, 1983), constituted considerable advances in discovering the importance of nar-

cissism throughout the psychic life and in reinterpreting its links with objectal relations. But they lacked the notion of the link between narcissism and the structuring, organizational function of recursion. When a complex dynamic system, pushed by the necessity of its self-organization, is led to loop its effects (the outputs, its efficiency) on the elements it receives as input, it develops in fine a process of self-regulation which requires an internal representation of itself and leads to a complete reorganization of its structure. This point, discovered by artificial intelligence modelling, is central. It can be approached intuitively by imagining the successive stages of a system endowed with the capacity to generate self-regulations and plunged into a moving environment subject to chance (random noise of reality). The first feedback regulation is comparable to a threshold automaton and does not require any memory. A second order regulation imposes the trace of the first order regulations, but this one can be only a control parameter modulating the threshold effects of the first order regulation. But when the evolution of the system - i.e. its survival - imposes a third order regulation, it becomes necessary to interpret the second order traces according to the past context and thus to use a representation of the global behavior of the system in a previous situation. This representation is a self-representation. Some of these self-regulatory systems are assemblies of loops that are genetically determined at the base and then constructed by epigenetic mechanisms (of the Piagetian type). But as soon as these regulations become of a higher order, they require a representation of oneself (the reflexive self).

Complexity of the Self

We propose to reinterpret narcissism as being the necessary recursive looping of the sexual drive on the "ego" for the development of an instance of a greater order of complexity "the self", qualitatively reorganized with respect to its previous state. In psychoanalytical terms, the (secondary) narcissism is not a simple stage of the psychological development, opposable to the object relation, but a structural component of the psyche allowing its complete reorganization in a global instance of increased complexity. Ego, I and self are thus three instances necessary to the description of the psyche. The ego exists in its opposition to the id and the superego, it is a first instance, managing the dynamics of the libidinal investments of objects (of love, of hate), diverting sexuality to its profit by the narcissistic love thus making emerge a new wider organization, the self, allowing the integration of the whole of the cognitive functions, the construction of the objective relations, the virtualization of the world by the thought and the individuation (demarcation of the other). From the beginning of the mental life, the innate recursivity of the libidinal investment (narcissism known as "primary") induces the generative development of the self provided with its properties. The I is the secondary incarnation of one of the structural, differential positions, inside the self, allowing the subjective enunciation.

By resuming the Freudian notion, the complexity of the self can be assimilated to a new topography. The first topography institutes the distinction between the conscious and the unconscious (pleasure principle/reality principle), the second topography institutes a distinction between the ego (instance managing object investments) and the superego, and the id and the unconscious becomes a quality. The topography of complexity reorganizes the two previous topographies by instituting the self endowed with singular functions and qualities. The establishment of the third topical does not invalidate the existence of the other two topographies, which

remain virtually functional and can appear according to the different states manifested by the self. On the developmental level, the first two topics are set up successively (the second topic with the establishment of the oedipal superego), on the other hand the third topic is in a different temporal relationship. It is set up from the beginning of the psychic life and envelops the two other topics.

The three functions of the self

The psychic self follows an ontogenetic development, necessary to the adaptation of the organism to its environment, with a status equivalent to that of the immunological self, and assumes functions selected for their adaptive operativity. On this point, we place ourselves in a naturalistic perspective by fully accepting the initial biological determination of the human being, individually subjected to the laws of Darwinian evolution. The genome thus has the status of a control factor of identical value to environmental control factors, whether they are individual or social. There is no absolute precedence of one type of factor over the other but a co-action of control on an internal dynamic of deployment. The evolution towards the complexity of the self is a notion coming from Lamarckian thought, not in the sense of the heredity of acquired characters, but in the sense of a constant push of biological structures towards complexification. The self is the ultimate phase of the evolution of complexity on one of the different evolutionary lines of the living. This does not mean that the complexity of a somatic organ, or even of an organelle, is less complex than that of the mind. There is a prodigious complexity at all levels of life. But the progressive integration of the organic functions during the evolution of the living leads to the necessity of development of systems of regulation of these functions whose integration leads to the development in fine of the fundamental psychic functions of the self. They are three in number:

Mental cohesion is necessary for the coherent management of the multiplicity of perceptive and interoceptive information and for the maintenance of an integrative unity. The self maintains its structural stability by regulations. It ensures the perceptive completeness, the vicariance of the functions, the sensory intermodality, the intentional construction. It thus assumes a major cognitive function by the possibility of unifying the components of the cognition in the intentionality. The holistic character of the self (self-adaptive maintenance of a constancy where the whole exceeds the sum of the parts) allows the management of contradictory inferences (cognitive conflicts) and the synthesis of mental objects made cohesive by the beam of the intention. Husserl's phenomenology and contemporary cognitive sciences make this function of intentional cohesion explicit. On the neuropsychological level, this function covers the executive functions, but it is not reduced to them, in particular by the role of the self-representation in intentionality. These aspects appear clearly in the phenomenon of virtual immersion where the attribution of a transient reality to a fictitious world is realized through a delegation to the avatar. The relation of the subject to the avatar is a virtual presentification of the intentionality, the effectuation of which sends back by recursivity an image of its own thought, thus contributing to its regulation and its growth. This explains the effectiveness of the use of virtual worlds in psychotherapy.

The virtualization, necessary to the realization of mental spaces (thought) in which the individual (the "psychic" subject) sees himself represented within anticipated, imagined, recalled mental scenes, allowing the generation of hypotheses, reasoning and the realization of de-

sires (Freudian fantasies). The mental processes of virtualization are conscious, others are unconscious in the qualitative sense of the term. Language is the privileged mode of virtualization. The generativity of the enunciation is enlightened by the property of emergence of the virtualization inherent to the complexity of the self. The virtualization is distinct from the notion of imaginary because it is not a passive process of submission to images imposed by identifications but an active process of creation of an internal neo-reality that can be projected by action in the real world, if it is not hindered by conflicts and inhibitions. The narration, the construction of a story are typically forms of virtualization.

The psychic individuation is necessary to the existence of an individual as an autonomous being in his achievements and in his thought. No two individuals on Earth are strictly identical morphologically (with the limited exception of the case of homozygous twins). On the mental level, individuality is without exception. Even if the banality of thought is a very common thing, no two banalities are identical. Something other than the similarity of the lived experiences, pushes to the psychic individuation. This individuation implies the recursivity of the self on itself and thus to the existence of the consciousness of oneself. Any complex dynamic system, endowed with capacities of self-organization, immersed in an environment including chance, evolves by modifying its interior states and by generating new morphologies and functions, including the self-observation of its behavior (Atlan, 1979). The ultimate evolution of a system endowed with self-organizing properties is the generation of an instance capable of anticipation, of making decisions, thanks to a reflexive consciousness. Self-awareness is certainly a philosophical notion (Hegel,...) but it is first of all a phenomenologically evident reality. This self-consciousness is a cognitive necessity. Thinking about something and anticipating an action requires the representation of oneself in an imagined mental scene where the action is virtualized. The singularity of a reflected experience thus necessarily induces individuation.

The properties of the self

The self is endowed with the self-organizing properties of complex dynamic systems.

Holism. It is a holistic instance, whose global functioning cannot be described by the simple juxtaposition of its constituents. Its nature is auto-poietic in the sense given to this term by Francesco Varela (1995) and corresponds to the holistic characteristics attributed by Goldstein to the organism (Goldstein, 1934). This property explains the feeling of unity and completeness, despite cognitive, sensory and motor deficits. It allows to compensate disturbances of functioning by internal autoplastic (thoughts, dreams) and external alloplastic (actions) regulations. This self-regulation of the self is teleonomic. It merges with its form of existence. The structural stability of the self imposes the cohesion of the elements of the physical reality which are given in a partial way by the perception by generating mental objects manipulable by the thought. The holistic property of the self can be brought closer to the metaphor of the protoplasmic amoeba used by Freud to describe the self and its investments (as well as by Federn with his theory of the double envelope of the self). It accounts for the phenomena of tension (anguish) and relaxation as well as for the traumatic ruptures by break-in and the phenomena of depression by deflection of the autopoietic capacity. The self is a mental instance emerging from the functioning of neuronal structures. These can undergo specific pathologies, inherent to the complication of their arrangement and to the hazards of development.

Contemporary psychiatry has shown that this biological level is causally involved in the occurrence of a large number of psychopathological entities. In fact, all psychopathological entities have a biological signature. For some of them, a modifying action of the neurophysiological bases by a pharmacological action acting on the balances of regulation between neuromediators leads to major therapeutic effects. On the other hand, all psychopathological entities, including non-psychiatric forms (neuroses), include a cognitive determination. This is not unique, it cannot alone account for the determination of a disorder, but it does exist and opens up a new field of operability. Cognitive therapies act on this level (identification of behavioral scripts, analysis of pathogenic mental scenes, bypassing of inoperative cognitive processes through remediation). However, the self cannot be confused with the arrangement of cognitive processing modules described by cognitive neuropsychology, nor with the meeting of neuroanatomical structures underlying mental functions. The self is certainly in a relation of dependence with respect to the neuro-anatomical structures (no psyche without brain!) but the description, even precise, of the functioning of these structures does not allow to make intelligible the functioning of the psyche. Thus, a neuropsychological organization can be damaged to a large extent, implying functional deficits in memory, language or reasoning, while at the same time revealing a preserved psychic functioning (except at the extreme limits). The functions of the self are distinct from neuropsychological functions. The self is certainly in relation with the nervous system as well as with the immunological and hormonal (neuroendocrine) systems, but as a holistic instance, it presents a psychic reality that cannot be deduced from its foundation. This opposition between the holistic global quality of the self and the local quality of a neuronal underpinning is perfectly explicit from the first levels of cognition. Recall that connectionism, one of the three paradigms of cognitive science, consists in modeling cognitive operations through the activity of networks of threshold computers, each built on the principle of a biological neuron. Beyond a certain threshold value obtained by summing up the incoming analogical influxes (summation potential), the neuron emits a binary value, discrete, in 0 (no action potential) or 1 (discharge of an action potential). Formal neural networks have shown their ability to bring out functions that cannot be deduced from their initial properties. Not only can the four basic logical operations (negation, and, or and or exclusive) be performed by various arrangements of these formal neurons, but by looping inputs to outputs, these networks perform categorization, association and indexing operations without these emergent functions being localized at any particular place in the network. A non-programmed, unplanned, delocalized "cognition" emerges from the experience acquired by these local networks. At the scale of a biological brain, these local properties become, at least conceptually, compatible with the notion of a global mind (Mind) emerging from neuronal inter-connectivity and capable of symbolic operations.

Structural stability. - The structural stability of the self is dependent on the limits of the regulation fields defining the stability levels (attractors of the system). Beyond the limits, the self bifurcates catastrophically towards another level. The set of its limits constitutes the regulation figure of the system. It is of a topological nature and comprises singular points of critical value. The self seeks to maintain its stability, which is constantly disturbed by (1) external events (hazards of life, bereavements, etc.) and (2) internal events (the impulsive demands of sexuality and aggressiveness) and (3) the difficulty

of maintaining a closed holistic system in an open universe. The intensity of an event can exceed the thresholds of the regulation figure and lead to a catastrophic breakdown of the regulation processes (psychic homeostasis). This is the case, for example, when a symbolic and/or real event occurs that the self cannot internalize because it lacks the cohesive mental representations to process it. Following regulation failures, the reduction in complexity leads to stabilization on a lower level while maintaining the holistic properties of the higher level. The reduction in complexity leads to a degradation of the coordination and connection centers, a tendency to local automatisms, a hyperactivity localized to certain functions, a degeneration, the functional division between emotion and thought (according to the psychosomatic model: essential depression, operative thought, automatisms, functional disorganization). In other clinical situations, somatization is avoided by the occurrence of a symptomatic depression or an avoidance behaviour. In other situations, the mentalization of the conflict by the creation of multiple mental links allows the deployment of new regulations and the absorption of the trauma. The pathologies known as "psychotic" are failures of the structural stability, subjected to the neurophysiological factors, and not the expression of conflicts between the self and a tyrannical ideal self or between the self and the reality.

Autism is a particular form of regulation of the self leading to a specific structural stability depending on original modes of regulation. The forms observable in psychopathology are thus not all built on the model of defense but many are conducts with a regulatory aim necessary to the maintenance of the structural stability of the self (and not to the balance of an ego threatened by the irruption of a drive representation). The complete degradation of the complexity involves the system beyond a level defining its existence and ends in its disappearance (death). The psychological notion of character (or temperament) also reflects the existence of this regulation figure. The character is the whole of the points with critical value of the figure of regulation of the self. This set cannot be modified without breaking the regulation, which induces its constancy and its rigidity. The establishment of some of these critical points results from the development of the sexual drive and its vagaries (oral, anal, phallic fixations,...). Other points are genetically fixed and owe nothing to the vagaries of libidinal development. This explains the family transmissions of character traits, of developmental styles, which the clinic shows to exist as well as the limits of univocal interpretations by a purely ideal transmission (unconscious identification, play of the signifier, etc.). It is possible to reinterpret the Freudian notion of death drive by considering it as a tendency to the degradation of the complexity (manifested by a reduction of the number of dimensions) going towards death. The Freudian notion of Eros (second Freudian theory of drives) is also reinterpreted. The Freudian Eros corresponds to the evolutionary push towards complexity, with its properties of emergence of new structures (or of increased differentiation) and of integration of functions.

Composition in attractors. - The constituent elements of the self are nuclei of stability, the mental states, comparable to attractors towards which their internal trajectories of evolution converge. An attractor characterizes the evolution of dynamic systems before entering a state of equilibrium. For example, a simple pendulum follows spiral trajectories that converge towards a fixed point. The system settles in a stationary state (attractor) which characterizes it. Other attractors exist (limit cycle, strange attractors). The knowledge of their precise topological nature (which can be multidimensional

and escape intuition) is not necessarily necessary to understand their structural interactions. Attractors can themselves be of complex topology. In psychopathology, the limit cycle is obvious in bipolar disorders (oscillation between mania and depression according to the relations of domination between ego and superego: manic exultation when the ego has overcome the superego, melancholic depression in the opposite situation). Psychopathology can thus be regarded as a landscape of attractors in competition, each one corresponding to a stabilization, sometimes metastable, of the structural organization of the states of the self. The attractors attract to them representations, fantasies, desires, identifications, and induce behaviors. Their coexistence exerts a dynamic tension on the self. The notions of fixation and regression are reinterpreted as relating to the domination of one attractor over another. If modifications intervene on the control parameters (phases and hazards of the development of sexuality, various circumstances of life and effects of traumas), then changes can intervene modifying the supremacy of an attractor over another.

In this modeling framework, the state space is that of the self, its cognitive operations and affective feelings, the control space is that of neurophysiology (the locus of neuromediator kinetics, the effects of hormonal regulation), and the bifurcation space is the set of genetic and environmental factors. If one or more of these factors present an intensity which goes beyond the figure of regulation of the self, this one deforms and modifies its space of phases. The forms taken by the self subjected to excess of constraint correspond to psychopathological realizations. The diagnostic entities are *extrema*, positional singularities on the response surface (phase space) of a dynamic system (the self) controlled by several factor spaces (genetic, neurophysiological, clinical). Psychic normality consists in staying in the passes and talwegs without falling in the *minima*. The psychopathology results from the disturbances of this system. Either by permanent oscillation (bipolar disorder), by the confinement in one of the positions (fixed point), or finally in manifestations of regulation intended to avoid the fall in one of the positions. A certain number of psychopathological entities present selective interests in terms of evolution and are associated with genetic stabilizations (Stevens, 1996).

Differential structure. - The attractors of the self are reciprocally determined within a differential structure. This structure necessarily comprises an empty place that can potentially be occupied by an instance. The self is thus a structural instance in the strong sense of structuralism (Deleuze). The self is constituted of a system of differential relations according to which its attractors are reciprocally determined and embodied in psychic instances in the sense of psychoanalysis. This structural nature is fundamental to understand the articulation between the individual and the anthropological structures. The individual possesses in himself a capacity of identification (actualization of an attractor) to attitudes and roles imposed by the anthropological structure of reception. The identification is a dynamic process, structurally constrained, imposing to the self to assume anthropological functions, defined by a culture. The structure of the self, endowed with a generative structural complexity, allows the articulation of the individual psyche with the anthropological structures. It is realized by the mediation of the differential game of the two attractors described by Kohut: either the grandiose self, trying to annihilate the existence of the social background by an overestimation of the individual, and the identification to an idealized parental imago generating the fusion in a collective ideal, with annihilation of

the individualized demarcation, position observable in ideologies, religions, societal alienations (consumerism, idolatry, subjection to the societal codes, fashion) The psychic individuation is the object of variations according to the different cultures of belonging and the different anthropological systems. In certain anthropological systems, the individual self is entirely under the domination of an extreme attractive position aiming at fusion in a community structure. The different modes of stabilization between the two attractors determine the variety of expressions of individuation, which can also vary according to the circumstances (war, for example).

Sensitivity to initial conditions. - As a dynamic system, the self is sensitive to initial conditions. The development of the self by progressive aggregation of its original nuclei in early childhood is strongly sensitive to disturbances. The importance of early traumas as well as that of childhood events are enlightened by this property, as well as the importance of the re-elaboration in psychotherapy of the real and fantasized childhood. The attention of psychoanalysis to early childhood is thus fully justified on the condition that it is not sacralized and that it takes into consideration the fact that the sensitivity to initial conditions can meet phenomena of resilience which protect the evolution of the system by imposing on it the stability of a regulatory figure. The clinic confirms the relative independence of early event conditions for development (except at the limits).

Historicity. - The self integrates the history of its development. This property of historicity enlightens the importance of return on oneself and the importance of the past in any psychological dynamics. The self keeps the trace of these traumas and of the regulations (sometimes pathological) that it set up to protect itself from the risk of destructuring. The historicity takes place on the scale of an individual life but it is not excluded that one can consider it on a trans-generational level, even phylogenetic. Let us recall a fact of psychoanalysis, on which Freud never gave in despite the opposition of many of his colleagues, including Jones: the analysis of unconscious contents attests to a phenomenon of recapitulation (timelessness of the unconscious) where phylogenetic "events" are re-actualized in the form of prototypical contents (original fantasies). Epistemologically, the Lamarckism claimed by Freud (hereditary transmission of phylogenetic traumas) should no longer be considered an insurmountable obstacle because today the possibility of a transmission of acquired characters, complementary to Darwinian selection, is no longer a dogmatic taboo (cf. Asano M., Khrennikov A., 2015). Insofar as the self is linked to genetic inheritance, and the genome is a control factor like any other that can be influenced by the environment (and therefore not totally encapsulated), the idea of a phylogenetic transmission of elements of a "semiotic" nature (traces of catastrophes, traumas) should no longer be evacuated as illegitimate.

Singularity. - It is singular. The singularity of the self is determined at the same time by the biological conditions of individual uniqueness, by historicity where no two individuals can live the same experience, and by the work of the self and of its function of individuation, pushing for demarcation. A trivial example is that of the push to differentiation existing in most siblings. The push for singularity can also be observed at the level of groups where it is opposed to the tendency to merge. We propose to understand the particular status acquired by sexuality (which has become a sexual drive in the Freudian sense and not a sexual instinct) by an adaptive gain for the human species. The sexual drive, thanks to the acquired independence towards these objects, exerts a function of gen-

erator of interindividual diversity by the variation of the investments. The sexual drive must follow a generic development leading to the object relation. Its hazards, described by psychoanalysis, are implied in the choices of objects at the bend of the oedipal organization (neuroses, perversions). An important part of the sexual drive is derived towards the maintenance of the self (secondary narcissism) and contributes to its individuation. The maintenance of the self (its holistic character) is similar to what Freud called the drives of self-preservation of the ego (first theory of drives). The sexual drive would thus play at the psychic level the same function as the meiosis and the genomic mutations operating a function of engine of variability. For the individual, as for the collective, the price to pay of this particular status of the sexual drive, lies in the risk of disorganization of the existing structures.

Emergence. - The last important property of dynamic systems is that of emergence. Complex dynamical systems generate phenomenological emergence. To take again the example of the pendulum, a simple dynamical system, putting a pencil on the ball of a pendulum thrown in a rotating way above a sheet of paper shows the drawing of a convergent spiral towards a fixed point, the attractor of the system. This property allows us to understand how a system situated at an intermediate level between two spaces of different nature can produce events, traces, in each of these two spaces. The oscillation of the pendulum does not allow us to visualize the attractor of the system, but its projection on the plane of the paper allows us to identify the attractor. Inversely, locating the drawing of a spiral on a piece of paper allows us to identify the oscillating dynamics that gave birth to it. Considering that the sheet of paper and the space of oscillation correspond to different substrates, it is understandable that the same dynamic system can express its nature in distinct plans of realization. The relation between the psyche and the neurophysiological spaces can be approached here in a new perspective. Under the pressure of the environment, the self generates topological singularities that become indexes, prototypes of emerging symbolic categories. The result is a new theory of representation. To approach this new conception of representation, it is necessary to follow the vagaries of the notion of representation in the different paradigms of cognitive science. For functionalism, the mind is assimilated to a processor of symbolic representations and the knowledge of the nature of their implementation is not necessary. This implementation can be realized indifferently in an artificial computation system or in a biological brain. These symbolic representations, organized in a lexicon and syntax, are interpreted logically by the lower levels and thus constitute a command language. To understand the functioning of the mind is to describe this language without worrying about the lower levels and by delimiting its constituent modules. For connectionism, the notion of representation is no longer necessary because neural networks (both artificial and biological) encode the properties of objects in a delocalized way within the layers of the network. Only the inputs and outputs matter and the behavior of a network is independent of a structuring in representations.

For the self-organizing paradigm - the host paradigm of our topography - the representation is conceived as a regulatory structure generated by the system to ensure its structural stability. The representation operates a necessary function but it is not a command language built a priori to pilot the lower levels of a system. The representation stabilizes the dynamic process by constituting an image, a sort of externalization in a controlled space of symbolic indexes on which it is easier for the organism to infer reg-

ulation behaviors than on the dynamic process itself, whose "somatic" energies are considerable and cannot be controlled. This has a fundamental consequence. The conscious representation is not the source of the initiation of the action. The conscious representation of an intention follows the initiation of the action and does not precede it as we intuitively conceive it. The conscious decision is not the cause of a movement but its consequence. The conscious intentional mental movements are not the causes of our actions but the reflexive markers of an already engaged unconscious action (Libert, 1985). There is therefore a cognitive unconscious where the flows of representations allow a re-evaluation of the action, an a posteriori control with a regulatory aim. In this perspective, the Freudian unconscious, constituted by repression, is a partition of this cognitive unconscious (and not the other way round). Operating a primordial function of structural stabilization, the mental representations are not amorphous structures but they present an internal structure that we can approach to know by retracing the course of their constitution from the visual perception.

Vision allows the formation of a first sketch of the perceived object from three successive operations. The first is an analysis of the sensory image of the object by the extraction of its contours (Marr, 1982). The second level represents the world as composed of surfaces in a three-dimensional space. The third and last level is that of material volumes and their properties. It is at this level that the higher cognitive operations take place, with the decomposition of forms into parts and the constitution of classes of objects. The construction of the mental representation is carried out from the coding of the contours of the forms. In a remarkable way, these data corroborated the theses of the philosophy of Edmond Husserl. The identification of the object, that Husserl calls logical synthesis, is subjected to an experience of the flow of the sketches. This flow of object sketches, multiple presentations of these apparent contours, constitutes a first "kinetic" synthesis. The identity of the objects emerges then from the perceptive intentionality comparable to a ray which crosses the flow of the perceptive sketches and allows then the synthesis of it. The synthetic operations with intentional aim constitute the essence of the whole of the cognitive functions known as "high level" like the memory, the judgments and the reasoning. The mental object is thus dependent on intentionality, which re-performs the work of synthesis in order to reconstruct scenes and scripts allowing the regulation of the action (but not its initiation). This conception of the mental object, consecutive to intentionality, is, in our opinion, fundamental for understanding schizophrenia and autism (Virole, 2011, 2015). It has the advantage of disengaging from the problems linked to the preconceptions of an internal representation. The function of stabilizing states of the self can thus just as easily be achieved by external representations. For example, the use of image streams in virtual worlds by people with autism is an external experience that performs a stabilization of their self. In other words, thinking is a virtualization of action (including abstraction conceived as internalized action). It is the object of an affective investment which can be polarized either in pleasure (relaxation) if the action is carried out or in displeasure (tension) if the action is hindered. The extension of this process spreads to the whole of the complex operations of the self.

Psychotherapeutic perspectives

Our conception of the self is derived from the therapeutic experience and in return it allows a reconfiguration of the psychotherapeutic technique. Psychotherapy implies a differential play

between the different topographies; in the first topography, the therapist's attention to the functioning of the patient's preconscious, to his capacity to fantasize, to dream, to associate, to make unforeseen mental links (etc.); in the second topography, attention to the conflict between instances, to the transference of objectal relations (and more profoundly to the investments based on the model of infantile sexuality, sadistic anal abutment in regressions, oral attraction in depression, etc.); in the topography of complexity: attention to the movements of restoration of the holistic character of the self (with the conflicts between two of the attractors of the self; the idealized parental imago - with its concretizations by ideological and religious fusions - and the grandiose self - with its concretization of megalomaniac individuation), attention to the modalities of the narcissistic transfers in alter ego, in narcissistic rivalry, in dependence. In the third topical approach, the aim is not to induce a regression that would bring out the oedipal and auto-erotic elements but to induce insights into the development of the self and to identify the obstacles (of all kinds). The central insight is linked to the identification by the patient of the nuclear program of the self, i.e. the project of realization of a life (in the internal history of a life). All progressive evolution of the self progresses asymptotically towards the realization of its nuclear program of realization (Kohut, 1971). It is carried out against a contrary force tending to its disorganization. The nuclear program of self is a constant force leading to the realization of objectives, purely subjective, in the concrete life or in the thought, and this by multiple ways, without being measurable with the particular measure of a cultural or social value. It can be as much an artistic work as housekeeping, a moral conduct, a professional commitment, a way of life... The nuclear program of oneself, defined since childhood, is totally idiosyncratic. It is even the essence of the individuating function.

The self can be unconscious of the existence of this program, which is revealed by the analysis. It is always noticed a posteriori by an astonished self of the presence "in itself" of such a determination. The failures of realization of this program (or its neurotic overinvestment) linked to the obstacles of reality or to intrapsychic, oedipal conflicts that hinder it, lead to a major suffering, of depressive tone, that can go up to essential depression. The rise in power of personal development therapies can be explained by the fact that conventional psychoanalysis does not take into account this psychic movement, which is prograting and aims at an individualized realization of the self. However, these new approaches neglect the internal negativity aiming at the disorganization of the structures, the ambivalence, the psychic conflicts discovered and treated by psychoanalysis. They are thus mainly suggestive techniques exploiting an idealization of the self. On the contrary, the analytical treatment, which takes into account negativity (tendency to disorganization, negative transfer, aggressiveness, negative therapeutic reaction,...) is certainly closer to reality but it is incomplete if it neglects this prograting movement of individualized self-realization and reduces it to reactionary formations, to a neurosis of destiny, to avatars of an object relation or even to a logic of desire centered on the imaginary illusion (object *a* in Lacan's concept). The complete psychotherapeutic act consists in offering the patient the space for the deployment of the three topics through a rigorous classical setting (neutrality, controlled dosage of narcissistic gratification, acceptance of transference, analysis of counter-transference) but also vigilant to the deployment of the three functions of the self (individuation, cohesion, virtualization of the self).

Articulation with anthropology

The self is the topography of higher complexity allowing the interface of the individual with collective systems (groups, societies, ideologies, religions) through the functions of individuation (being oneself in relation to others) and virtualization (anticipatory projection of self-realization). Certain pathological forms of the self thus specifically affect the relations between the individual and the collective organizations. To seek to describe the interface between an individual and an ideology (or a religion) does not mean to seek to explain the whole of the determination of an ideology - which engages an approach of philosophical nature (Spinoza, Hegel, Marx) - but to understand the articulation between a collective external structure and an individual internal structure. Reasoning within the complexity allows us to think in a different way about certain anthropological problems. Let us recall the essential data of structural anthropology. There is in the human mind a necessity of differential categorization. The myths do not only solve the question of the origin, by putting in discursive, syntagmatic narration, a categorical opposition, deduced empirically, (empirical deduction), but it infers, by a transcendental deduction, a new opposition allowing the redeployment of new structural categories (last term of the canonical formula of the myths in Lévi-Strauss). There is thus an internal necessity to the mind to maintain a generative system of differential oppositions. Lévi-Strauss hypothesizes that it is a necessity proper to the cerebral functioning. Thus, for example, if for the Freudian psychoanalysis, the fetish is a symbolic substitute of the penis (possessing with him a metaphorical or metonymic link), in structural anthropology it is without univocal meaning but is determined by a network of differential oppositions organized by serial laws. There is thus a structural over-determination (an effective) of attitudes (positive or negative social relations) within a family structure, itself always composed of four terms (father, mother, child, and mother's brother) in order to allow exchange.

The relations of "psychological" attitudes between these terms are determined by differential oppositions, necessary to the structure. The family attitudes are not therefore explained by personality singularities, or idiosyncratic reactions to life events, but by structural necessities which define the framework, the format, and therefore the thresholds, within which they can vary qualitatively. In other words, the subjective construction is not the unique resultant of the individual history (genetic, eventual, traumatic, seductive, relational, conjunctural) but is determined also by structural places (positions in the systems of kinship, filiation, in the culture). We pose the hypothesis that the structure of the self, endowed with a generative structural complexity, allows the articulation of the individual psyche with the anthropological structures. The social and cultural forms are considered as stabilized forms of a dynamic of conflict between the requirements of the individuation and the requirements of the maintenance of a collective organization going against the individual interests. For example, one can interpret the religious facts in first topography and look for the effects of repression, of symbolic disguise, of censorship and of lifting of the censorship in the rituals. One can also interpret them in terms of second topicality by specifying the instances and the oedipal conflicts put in play in the religious phenomenon (assimilation of God to the primitive father, the Eucharist as a variant of the totemic meal, etc.). It can also be interpreted in terms of the topography of complexity by considering the way in which religions manage the conflicts between the self and the collective, or even aim at the annihilation of the self (as in

most oriental religions). These three levels are complementary.

In the analysis of collective facts, as in that of the psychic reality of an individual, the technical stake is not to oppose them as generating contradictory interpretations, but as being angles of view affixed on the complexity of a same phenomenon. In the same way, in the clinic, in front of any psychic phenomenon (moral pain, missed act, slip of the tongue, irritation, depression, overwhelm, argument, hesitation, etc.), a double movement is necessary: the first one is the one that is the most important.), a double movement is necessary: (1) an analysis in significations, by the research of the unconscious displacement, of the latent sexual meaning, of the repression of affect, of the symptomatic detour, of the libidinal investment, of the regression to a previous level, of the defect of mentalization (etc.); and (2) an analysis in structure, position and singularity, imaginary splitting and symbolic differentiation, subjection to the laws of structure. It is the complementarity of these two focal points, one centered on singularity and seeking to understand intrinsic determinism, the other centered on differential position and thus extrinsic structural determinism, that allows for the complete intelligibility of the phenomenon. The topography of complexity, by its dynamic nature generating structural positions (differential play between its attracting positions) is the place of this complementarity.

Theoretical perspectives

We have outlined a conjecture that has many flaws and may seem excessively speculative. It is however the result of a constant dialectic between a clinical experience of psychotherapy and psychoanalysis, acquired over a professional life, and a theoretical reflection. Today, we cannot think of the clinic outside of this conjecture which offers us the possibility of making intelligible, at least, the dimensions of the complexity of human situations. This conjecture also offers tangential perspectives, the most important of which is perhaps to provide a framework for theories on the emergence of consciousness. The nature of this emergence is still unknown. We do not know how the process of consciousness emerges from neural matter. It is not even sure that the question is correctly asked. Our conjecture consisting in postulating an instance, the self, which cannot be localized in such or such neurophysiological structure but which emerges from the neuronal functioning and depends on intentionality seems to us to be in phase with the most audacious theories of consciousness, namely the quantum theories. The brain is composed of atoms, therefore of particles, and is thus necessarily the seat of quantum phenomena. The release of neurotransmitters at the synapses is controlled by the action of calcium ions, the size of a manometer, which pass through channels of similar size. At this scale, the phenomena that occur are quantum in nature. If we project the quantum properties to the scale of a mental self, we obtain features that are both astonishing and also surprisingly resonant with the properties of complexity: there would thus exist in the self a superposition of mental states, coexisting in spite of opposite valences, indestructible, unaltered by time, and one finds there properties of the Freudian unconscious; there would exist an interference between locally distant objects, a proposition unacceptable within the framework of a naive physics but yet in phase with the mental phenomena of intrapsychic communication; the quantum property of entanglement between objects strangely resembles the phenomena of objectal fusion and projective duplication. The spontaneous oscillation between attractors without any external

force could explain the periodicity observable in psychopathology.

But the most interesting quantum property is that of decoherence, which leads to the selection of one state rather than another. The temptation is great to see in consciousness, which is permanently a selective agent (William James), the expression of a phenomenon of decoherence. Thus one of the functions of the self, the coherence by intentionality on a state would be dependent on a decoherence at another level! Although there is a conceptual leap that cannot be crossed today between the scale of cognitive phenomena and that of quantum processes, the idea that consciousness arises from a phenomenon of decoherence between superimposed mental states opens up surprising metapsychological perspectives. Perhaps, our conjecture could inspire a space for these perspectives, their refutations, their inflections or their deployments?

Organic summary. - From neuronal interconnectivity emerge cognitive processes of categorization and symbolic indexing that constitute the first level of mental activity. This first cognitive level is biologically oriented, in large part genetically determined. It includes adaptive affordances, reflexes and innate behavioral scripts. This level follows an ontogenetic development and persists into adulthood. Its initial development constitutes the primitive self oriented towards external objects selected for their adaptive valence (projections, contours, prominent stimuli). On this orientation of the self toward the adaptive objects, a singular phenomenon occurs in man, which is the support of the sexual drive. The independence of the sexual drive with respect to the goals of reproduction and its constitution in partial components associated with the organs of exchanges between interior and external environment (erogenous zones) is a fact shown by psychoanalysis. Certain external adaptive objects are invested of sexuality (libido). Their withdrawal or their absence generates biologically determined behavioral reactions (frustration, anger, depression) but it generates an internal representation ("hallucination of desire") of the missing object thus allowing the genesis of the thought.

The self thus contains in it a representation of the missing object. This inclusion in the self of the representation of an external object imposes a differentiation. This one is the base of the recursive return of the love of the self for the self by constituting inside this one the differentiation of an organized authority that we name the self. The recursivity of narcissism differentiates a part of the self in an instance endowed with a particular structural dynamics which is that of the complex systems. The self possesses particular properties (holism, structural stability, sensitivity to initial conditions, singularity, historicity) and assumes three functions: (1) cognitive cohesion allowing the integration of perceptive data by intentionality, self-consciousness and body image; (2) virtualization by the genesis of a mental space where the self is represented by an agent within virtual scenes allowing anticipation, recollection but also daydreaming; (3) individuation by the differential play of identifications within the organization of the self defining structural places. The self has its own psychopathology, particularly observable in the so-called "autistic spectrum" disorders and in narcissistic depression, in addictions, and its consideration has implications in the psychotherapeutic technique. On an epistemological level, our conception of the self defines a topography of complexity allowing to reconcile the central contributions of psychoanalysis, structural anthropology and cognitive sciences. It opens perspectives for the understanding of ideological and religious alienations.

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