Article

Representation & the Figure of the Observer

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Abstract

The theoretical use of representation faces, among others, two types of inconsistencies, namely: a representation requires the figure of the agent to which it will be representative, which leads either to circularity or to infinite return; and the resulting one, which is the difficulty in reconciling a description, in representative terms, with other more fundamental scientific categories. The proposal of the present study for the solution of these problems was the identification of a referential process starting from the correlation between states of a physical system. It will present an inference about how the superposition of causal history moments of a system can result in a self-referential structure.

Keywords: Representation, self-reference, superposition of states, consciousness, observer.

Introduction

The notion of representation is one of the most controversial subjects in the study of the mind. Although this concept inevitably appears when the properties of the mind and thought are analyzed, there are problems and inconsistencies in their theoretical applications. There is no approach that adequately explains how the transition between physical and representative properties occurs, nor how the mind can be included in the representations without an infinite return of other representations.

The theoretical model proposed to explain a given natural domain should be able to explain and classify, with a set of concepts, a stratum of reality without requiring external elements that are not adequately classified by this model. However, with respect to the use of the concept of representations, this rule is not properly obeyed, since it also implies the necessity of an instance for which they are representative.

In their theories of ideas, modern authors could not exclude from their models the mention of an 'I'. If an attempt to deal scientifically with thought is to present it as a mechanism of articulating ideas, which are related to external reality, these authors could not avoid postulating an entity that centralized ideas and perceptions. For Descartes (1979), the knowledge of external bodies is not originated from sensation or imagination, but because they are conceived by thought, i.e., deduced. While the knowledge of external things, intermediated by ideas, is confusing and doubtful, Descartes states: "For me, there is nothing easier to be known than my spirit" (ibid., p. 98). To explain how simple ideas become complex ideas, Locke (1988) mentions the percipient

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mind as the one that observes and makes operations using ideas. This way, it not only receives perceptions, but it actively manipulates them. This author explains how inner perceptions become ideas using the own analogy of sensory perception:

> The mind receiving the ideas [...] from without, when it turns its view inward upon itself, and observes its own actions about those ideas it has, takes from thence other ideas, which are as capable to be the objects of its contemplation as any of those it received from foreign things. (ibid., p. 40).

If ideas are mediations of reality that follow each other in different ways of representations of the external world, then, there should be an agent evaluating them, watching them, in a Cartesian theater, according to the metaphor used by Hume[1]. If ideas are like pieces of machinery to be investigated, postulating an instance that observes them makes their complete appropriateness unviable in scientific terms, since something always remains one step beyond what is explained.

The notion of thought as an association of symbols (mental particles[2]) of modern philosophy was inherited by cognitive theories in the twentieth century. Among them, it is possible to highlight Fodor's theory of mental representation (1975), who argues that thought consists of a syntactic articulation of symbols, constituting a language of thoughts. However, even borrowing the concepts of syntax and computation in the treatment of symbols, which is supposed to be an advance over modern concepts, the theory does not take into consideration the essence of the representative problem.
When perception is analyzed, two elements are always considered, namely: the observer; and the observed. However, when this concept is used as an analogy to explain how the mind thinks

[1]Hume (2009) explains why the idea of an "I" is incoherent. He affirmed that we are only aware of the series of experiences: "The mind is a type of theater, in which diverse perceptions make successively apparitions" (p. 205). However, we cannot infer the existence of continuous "I", since we have the propensity to see connected things only because they occur sequentially. The author states that this is a limitation of reasoning: seeing things as connected and unified is something we put into the stream of thought. However, he was unable to eliminate in his objection the instance that attributes continuity to the series, or to which it is seen as something unified. Kant (1999) followed this line, which he called the unity of apperception. According to this author, representations only become knowledge insofar as they are unified in a synthesis, in an intellectual act originating from the own mind. The reference is not only directed to scattered representations, or to a series, but to the element that connects one representation to another, thus attributing unity, i.e., consciousness of that unity—the simple intuition "I think." This way, while the notion of a centralizing entity is scientifically uncomfortable, it cannot be easily circumvented or avoided. This approach, however, is still problematic and generates what he called a paradox. On the one hand, we have the unity of apperception, as the result of an intellectual act that brings together all the distinct representations into a single one. On the other hand, we have the inner sense, which is only known by the mind itself when it is affected by itself in time. Even though he differs from Hume by rejecting the model of a mind as a mere spectator in the face of what occurs to it, Kant was not able to solve the problem of how to reconcile the mind that thinks with the mind that is the element thought or observed.
[2]Popper (1995) analyzed the fact that theories of modern ideas make a parallel between mental events and the laws of physics (a science that progressed from the studies conducted by Kepler, Newton and others): the principles of connection and association of ideas would be the mental equivalent of the laws of motion. The author called this issue "doctrine of ideas as particles of the mind".

about itself and identifies itself, we should postulate a part of the mind that is distinguished from the phenomena observed, referring to them, but apart from what is perceived or identified. This way, the figure of the observer cannot be included in the same reality of the phenomena observed, since, with each new attempt of classification, there is a regression to a level in which the same double classification repeats itself. If the representation is an action of the mind directed to it, the act will presuppose this direction before being performed. The represented mind will be the same mind to which it is represented, which is paradoxical.

Another aspect of the problem is the so-called "homunculus fallacy", which theories of ideas association and, later, computational theories, failed to prevent. If self-reference is a theoretical challenge, the very definition of reference is scientifically problematic. It has always been necessary to use, even if not clearly, a last level of observer that uses symbolic processes. The fallacious aspect in this type of theory consists in the attribution of an autonomous existence to elements that only exist as such in relation to an external observer (Searle, 1998). Elements such as "information", "representation", and "symbol" can only be properties of something if someone considers them as such, since they do not exist in terms of their mere physical classification. In the case of computation, assigning the property of being a syntactic mechanism to an element depends on something external to it in the form of semantics. Thus, it will always be necessary to postulate a homunculus that sees a physical process as 0's and 1's, discreetly interpreting the physical states of a device that cannot be discrete. Therefore, "the only way to make syntax intrinsic to physics is to place the homunculus within physics" (ibid., p. 305).

If an element is representative, it has value not only by itself; it refers to something beyond itself, presenting a reference to something outside its purely material domain. While the causal relations of the physical world have their own, concrete, and self-justifying value, representative properties have a relational and ethereal value that communicates and brings together different elements in a single point of information. What makes a phenomenon that belongs to mere causality a representative element?

There are several descriptive levels according to which thought can be dealt with, from the biochemical level to the behavior of brain structures, all of which have an objective scientific existence independent of observers. The representative level, however, only exists for the person. This way, how can the reality of representation be related to objective reality, or how can a essentially representative descriptive model be identified within material reality?

Ryle (1949) discussed this problem and explained that the human body is subject to mechanical laws that govern other bodies and can be identified by any observer in the same way. However, the inner life of a person cannot be witnessed, it is private, and, as a result, each person lives within two parallel histories. The laws that bring together public and private life cannot be adequately formulated in any of the domains. These laws can only be mysterious, because mental operations are just formulated as opposed to physical descriptions. Such operations are not modifications of matter; they are not the mechanism of a clock; they are parts that do not belong to this mechanism. "This way represented, spirits are not simply phantoms chained to machines: they are ghost machines themselves" (ibid., p. 20).

Without an adequate solution to these questions, it is difficult to find a solution to present the notion of representation in a logically consistent mechanism, without the permanent necessity of postulating some external element to the model, or without falling into circular definitions. This way, there is an impasse in the search for reconciling the representation—and all its explanatory power relating to the behavior of beings—with the scientific description of other levels of reality. The problem to be solved, then, is the formulation of a theoretical model capable of implying the self-referentiality of a structure. A proposal for a solution will be the theme of the present study.

Causal possibilities and consequences

A physical system is a portion of reality considered in isolation, and whose evolution can be described from the succession of modifications of its initial situation, excluding external factors beyond its original definition. A system can have any boundaries, but they should be clearly specified if used as explaining factors for that evolution. Each state of a system is the set of descriptive properties that it possesses at a given moment, considering its margin of possible modifications. A state of a physical system has its "causal possibilities", which are the modifications to which it is impelled due to its current configuration, i.e., it is the immediate future of the system determined by its specific organization at a given moment. It also has its "causal consequences", which are the effects of past states that are inherited by the system and constitutes its present moment.

A current state conveys its causal consequences to the future of the system, i.e., the causal possibilities of this state. However, they will no longer influence the subsequent states. Although the causal consequences of earlier states can be identified, the earlier states—the moments in the history of the system with their causal possibilities—are no longer part of their constitution. Even if the examination of the consequences allows having a good clue of the events that determined them, they no longer have a causal power. One state conveys its causal consequences to subsequent states, but not its own causal possibilities, which are lost, failing to be part of the reality of the system.

The same state and its specific spectrum of causal possibilities may be originated by different previous circumstances. Different mining, transport and mixing processes, in addition to processing of ores, can form two identical metal bars, with the same behavior when subjected to a number of conditions. Presumably, it is possible (although statistically unlikely) that the molecules of a cup of coffee reach exactly the same position and velocity at two distinct moments, even if each one is formed by a different anterior series in terms of positions and velocities.

In causal terms, the series of states by which the system has gone through makes no difference for the possibilities of a state, given that its momentary configuration presents itself. In the same way, the states that have taken place due to different alternative histories also have their own possibilities, which are independent of their own previous series in a regressive manner.

Superposition of states

A parallel can be established between this discussion and the area of mathematics called Markov chains (Norris, 1997). This area allows the probabilistic analysis of random systems without memory, i.e., in which a future state is only determined by the present, and is independent of any previous states until it is verified; everything that has happened is irrelevant. There can be chains of discrete time, or continuous time. This second case can also be called Markovian process. Each state has a constant probability of being the current state of the system. The probabilities of reaching a given state from any other state can be listed and analyzed in the form of diagrams and matrices. The set of possible states of a chain is called space of the states.

The diagram of a Markovian system can be presented as a set of points, representing the possible states with a set of lines connecting them, so that it is linked to some states and not to others. The line that links two points has one direction, but not necessarily the reverse. A point may even be linked to itself. This fact allows indicating which points (states) are possibly obtained from any other given point, as well as the number of minimum paths which are obligatory to reach it. That is why the total possibilities of the system at one point are always the same, regardless of the modes (lines) through which the system has reached it. If the system had to go through three points to reach point A, or followed a path that led to A, through only one intermediate point, it is irrelevant to the analysis of the future possibilities of point A, given that they will always be determined by the lines coming out of it.

Therefore, non-Markovian systems can be considered as those for which the trajectory, i.e., the causal history, is relevant to current possibilities. From this perspective, it is possible to make two interpretations when considering a state. It is possible to analyze the current state of a system by the causal consequences inherited from past states. From these consequences, it can be inferred which series of events determined the present constitution. It is possible, however, to consider a system in which each state is constituted by the own causal possibilities of its previous series. If a state is constituted by its causal history, it makes a difference if point α was directly reached by means of a point k ($k \rightarrow \alpha$), or if it left k and followed the trajectory of lines, e.g. $k \rightarrow l \rightarrow m \rightarrow \alpha$. There is even a difference between $k \rightarrow \alpha$ and $k \rightarrow \alpha \rightarrow \alpha$. The causal possibilities of point α will then be the sum of the possibilities of each of the points of the trajectory, and not just the set of lines that come out of it in the original diagram. In the second interpretation, the system "superimposes" the states, rather than simply passing through them.

It is possible to postulate that certain types of systems can only be adequately explained when considering that they superimpose their different moments in time, preserving their previous states simultaneously with the emergence of new states. When a certain state E is paired with any other previous state, such as A or B, E has two different "tonalities". There would be two new E states, i.e., $E + A$, and $E + B$. Even if two states, which originally have the same causal possibilities, have a different origin in terms of their previous series, they will not be the same state. What can define a state E of this system is the causal history of the system up to E, and not only the causal possibilities of E.

This idea of superposition of states is not related to the superposition principle of quantum physics[3]. The quantum concept, applicable to subatomic elements, is based on the hypothesis that there exists a set of probable states for a particle at each moment. The sum of possible candidates to states of the particle is considered a state in itself. Each of these states is described by a vector, and the superposition of these states is a new state. Penrose (1989) states:

> Quantum mechanically, every single position that the particle might have is an 'alternative' available to it. [...] all alternatives must somehow be combined together, with complex-numbers weightings. This collection of complex weightings describes the quantum state of the particle. [...] I am taking the view that the physical reality of the particle's location is, indeed, its quantum state (ibid., p. 270)

Therefore, a quantum state can only be described by the set of probable states in which a particle is found. The different stories in this case are the different alternative possibilities of a system, for the same moment, and not a set of past states superimposed with a current state. Also, the idea of superposition, as the sum of simultaneous influences on a given physical medium, such as the propagation of shock waves or electric currents in linear circuits[4], is not analyzed here.

[3] According to Dirac (1947), in classical physics, a state can be fully determined from numerical values assigned to specified properties. When we have a very small system, however, we have a limitation of the observation power, and thus, difficulty in recognizing and assigning data to the system. If a system is small, we cannot observe it without producing a serious disturbance and, therefore, we cannot expect to find any causal connection between the results of the observations. The limitation of the observation power in small systems places a limitation on the amount of detail that can be identified. This way, the superposition of states is a tool for dealing with indeterminacy. The author states: "between these states there exist peculiar relationships such that whenever the system is definitely in one state, we can consider it as being partly in each of two or more other states. The original state must be regarded as the result of superposition of the two or more new states, in a way that cannot be conceived in classical ideas. Any state may be considered as the result of a superposition of two or more states [...]. Conversely, any two or more states may be superposed to give a new state." (ibid. p. 12).

[4] The superposition theorem in electric circuits states that, in a linear electric circuit with independent sources, the current or total voltage values are equivalent to the sum of the currents or voltages of each of the sources taken in isolation. The theorem is only valid for linear measurements, from which, for example, power is excluded.

Rather, the idea is that the actual (and not the possible) states that occur in the system are confronted with each new state of the system.

The concept of "continuous superposition" can be taken into consideration when a system is superimposed with each new current state, the series of states that have resulted within it. A state is then constituted by the series of previous states that constituted it, and this is regressively true for each of its component states. This way, the progression of the system in time is systematically constituted by its states being accompanied by its previous series.

In this case, there are two possibilities. In the first, the system is able to maintain the influence of the previous states concomitantly with the appearance of new states in a permanent manner. This fact, however, would not be feasible, since it should always be able to integrate more states into itself. Given that a physical state of any system has an energetic component associated with it, the ability to expend a progressively greater amount of energy would be necessary. In the second possibility, the system preserves its states within a boundary, which allows it to keep the energy-time relationship constant. For any moment of the system, its general state consists of a constant proportion with its past states, what can be called the "superposition field".

Therefore, in this second alternative, the viability of the hypothesis of a system whose description of each state is adequately described by the superposition of the previous ones is maintained. Continuous superposition is preserved, even if there are past states that no longer make part of the superposition field, or whose influence is continually diminished.

Memory, information and causal isolation

If the conceptual analysis of a system with memory is the capacity to rescue the causal history only starting from the inherited properties of the past moments of the system, i.e., the transference of the causal consequences, then the memory is nothing. The definition of memory as inherited causal consequence is not enough to isolate a real classifying property, since everything in common reality has this characteristic.

The definition of memory for the present analysis should be the possibility of rescuing the own causal possibilities of the previous states of the system, and not only the consequences. Memory, defined as the rescue of causal history, cannot be removed from the transference of causal consequences, since:

a) It is possible for a physical system to have the same specific characteristics by different alternative manners.

b) The properties of a system at a certain moment do not have in time nor in space a unique set of factors that can be isolated from others that are beyond the size of the system.

> Therefore, it is not possible to know exactly to what extent only the system itself or other external conjunctures were determinant for a given property.

Information can only be intrinsic to the system when each state keeps its own causal history. However, this is possible when only the states of the system, and not other external influences, determine the constitution of its future states. Any portion of reality, however, will be contained in the midst of the infinity of other relations. Depending on how a physical system is regarded, it can be considered up to the limits of the universe. Therefore, this uncertainty of the boundaries of a system should be resolved when one considers a system that is able to combine the moments of its own internal evolution. Somehow, the system should be isolated, so that the influence of its preserved previous states occurs in future moments.

A system isolated from any external variables, such as gravitational and electromagnetic forces, is only a theoretical concept and nonexistent in the real world. Given that complete isolation does not exist, the expected factor to make the hypothesis discussed consistent is that the system has a structural stability, maintained under constant external influences. This way, the manifestations of the possibilities of the system at each moment of projection toward future states is the result of the effects of the system itself, not being mixed with other influences of unknown origin and extent.

The idea of causal isolation is compatible with the general notion of integrated information. One of the main efforts undertaken in its investigation, the research field called "integrated information theory" (Tononi. 2008, 2012)[5], explores the characteristics of systems in which the interaction of communication between its points (such as a network of neurons) generates a level of information that cannot be found in its units considered in isolation. The theory seeks to formalize the properties of this information as opposed to physical systems in which the information is not integrated. The localized variations of its parts are not propagated and

[5]The classical notion of information is defined as a measure or estimate of the uncertainty relating to the number of coding alternatives, given the number of alternative states of a device, or possible paths between them. If a system is composed of a wide integration between variable units, and the states are not only determined by the uncertainty of the situation of these units individually (as in the case of pixels in a photo) but also by their integration into broader interdependent levels of variation, there is another interpretation of the total information of these systems. These complex informational states are beyond the description of individual points, which are not identifiable in their perspective—according to the maxim "the whole is greater than the sum of the parts"—and this emergent "information cloud" is seen by the author as the key of the explanation of the conscious phenomena. This possibility of complex articulation creates a wide range of possible differentiable states. This differentiation between states, discriminated by the brain, is equivalent to the varied collection of mental states as opposed to each other. The author proposes, however, a model of integration *without temporal superposition*. He does this by adopting as criterion what he calls the "principle of exclusion", in order to reconcile his model with the classic concept of information, for which the informative character of a repertoire of states lies in the degree of differentiation between them—states undifferentiated or "mixed" are not very informative. In order to explain the time evolution of states integrated in block, he uses the conditional probability, i.e., the estimation of transition possibility between groups of states mapped in a Markov chain would correspond to the "intrinsic information" of each state.

distributed and they do not contribute to a more general level of information that transcends the mere sum of the description of particular modifications. If the system does not lose information (or it is little dissipated), and it is decisively redirected in the general determination of internal states, there is another way of thinking in causal isolation.

Self-reference

We analyzed the hypothesis of a system of superimposed states. It is the concept of continuous superposition, which requires a constant proportion of past states influencing the system in a progressive way and the condition that it is an integrated information system, i.e., isolated from external influences in the determination of its future states. We will present an argument to show that a system with these characteristics will have a self-referential nature.

Every physical system has a momentary impetus, which leads it to its future states, determined by specific structural characteristics and the physical properties related to them. Given its present configuration, it is impelled to a given future state. They will determine what the system will become. It can change, or remain the same, as an inert body. It is also possible to isolate from a present configuration those which are clearly disconnected from the system. A portion of glass shards on the floor cannot return to the table constituting the cup of coffee that has fallen.

Applying this concept to a system of superposition, we have the following case: the system is formed by the previous states in their succession, so that each one is projected on the current state, and this is also true for them in a regressive way. A superimposed state has not only its momentary description as internal information; the history of the descriptions up to it is part of that information. Instead of momentary impetuses, the internal information will be that of a dynamic transition between them. Each new factor of modification of the general state is confronted with the history of internal tendencies, and the dynamics of this confrontation gives it the informative character of the degree of change. A common physical system will not have this characteristic, since the same causal impulse can be determined by different alternative histories. In innumerable ways, a cup of coffee can be considered with the same causal possibility, i.e., being close to falling from a table and become just glass shards on the floor.

In this way, as a state is formed by the causal history that determined it, this state will convey this property to a future state, i.e., the latter will be the result of the previous ones. Given that the dynamics of transition (motion) is part of the momentary state, *the manner in which it was formed will determine—at its current moment—that, as a state, it will be a component of a future state*. As each step of the past has its relative future state accumulated, this relation extends and applies also to the current state, so that it will also be in a projective perspective with respect to its future. There is already in it a component related to the past and to the future of the system that established it.

Each superimposed state has already elements that are "beyond it" as its components, i.e., the series of steps of the system that constituted it, and the future of the system as a result of the way of its constitution. The past moments that occurred in the system and its own future, as its immediate consequence, are intrinsic to each particular state, having itself as a constituent element. Each state, at a particular moment, is composed of:

> a) The previous series that constituted it. Past moments no longer exist, but in the causal reconstitution of the states that resulted in the current state, identified in their effects on the system, there is a reference to the past moments of the system.
>
> b) Its determination as a component of a future state, a result of how it was constituted. The future state does not yet exist, but there is already a reference to this future state arising from its internal dynamics.

This way, each state makes reference to those elements absent from its momentary reality. In a non-superimposed system, the characteristics of past states are contingent upon it and, thus, the constitution of its present moment does not retain information about the way in which it was formed. Consequently, it does not include its participation in the future of the system.

As a system of superposition keeps within itself its own causal history, there is a reference to the past states that constituted it as such. Likewise, the state refers to the future states of which it will be a component, as a consequence of the dynamics by which it was formed. Therefore, in a generalized way, each state of the system makes reference to the process of superposition in the time that established it.

According to the integrated information theory, integrated states are composed of the broad articulation of parts interdependently, resulting in a significant increase in the possibilities of general arrangements, creating a wider spectrum of differentiable states. However, from the simple possibility of the existence of a range (even if vast) of states, such as partial and individual versions of the same entity, it is not shown how information can become intrinsic, even if this spectrum is only determined by its internal articulations.

The linking of all these specific behaviors to some general property that determines them is a condition for such a fact. A reference of each state to such properties is required. It is necessary to show how the information acquires a global perspective[6]. It is necessary that general

[6]How the moment is inserted into the continuum, how an effect relates to its cause, and how these are effects of an earlier cause, and so on.

properties are part of the information of particular states. The reference to the process[7] abstracts any particular state, having it as a mere possibility before a field that generates states.

The various possible behaviors only materialize into internal information in the face of the superposition process. This property determines all the dynamics of the possible states. It is the permanent element in the face of which all changes are causally significant. The superposition makes the internal information dynamic, i.e., the information bends over itself[8] at a level that does not exist in the course of the evolution of common systems. In the midst of a superposition process, the existence of each state in a temporal causal process, which is broader than itself, becomes intrinsic. With this, the system in each "atomistic" moment exhibits transcendence to its temporal and causal locality contained as internal information.

The structure, as physical architecture, is the element that allows its states to be formed by the former states in their succession. It is shown at every moment of the system as the element that establishes them as such. A superposed state contains a map of a causal variation, and do not only consist of particular moments of that variation. These maps are samples of the spectrum of possible behaviors of the structure, which are progressively consolidated into new states. Therefore, each state makes reference to the own structure that establishes and sustains the process. The different moments of the structure are gathered together in each of its states and, this way, it continually projects itself upon itself in its effects.

The behavior of maintaining a system that continually superposes its different moments in time will represent a property of the structure. This behavior, as general capacity and not just as a specific series, becomes the element projected on the structure. Therefore, superposition is not

[7]Superposition can be understood as an integrated information network "in motion", i.e., the information levels of the sequences of events are holographically recorded and coexist simultaneously. The holographic principle (Talbot, 1991) is the postulate that the information of a region of space is coded in its neighborhood, according to the maxim "the whole is represented in the part, and the part in the whole." It would thus be theoretically possible to reconstitute an object from his light reflected on a wall, or projected onto a photographic film. The holographic principle has a close relationship with the notion of integrated information, since the relations between the points of a network with this property have such interdependence that the information of a specific region cannot be treated separately without losing its physical sense. Applying the holographic principle to the pairing of states, the chaining of events is such that a moment of movement contains the whole movement encoded up to it. The whole information of the movement contains the coding of each of its stages in a "recursive" way. Besides being the spaces in the surroundings, the neighborhood represents immediate moments toward those in the past. From the present state, it is not only possible to reconstitute the past but to project the future.

[8]A dimension is the variation range of a property. Each new parameter of variation establishes a new dynamic within which the property is considered with respect to others. The axes in space, for example, are the parameters that define the location of a body. An object in one dimension can be transported to a smaller one, but, in this case, there is a loss of information in its reduced version. This is what happens, for example, when we see the shadow of a three-dimensional body—a descriptive level is lost during planning. If time is considered a dimension, the total displacement of an object in a time interval can be considered a four-dimensional object (Kaku, 1994). In this case, particular moments are three-dimensional objects within a four-dimensional dynamics. Similarly, we can consider that, given the temporal dynamics of a superimposed system, when its instantaneous location transcends a state seen as three-dimensional, it is actually beyond this dimension in informational terms. One cannot explain a brain organelle without observing its interaction with the whole brain. Similarly, one cannot explain a moment of the brain without considering it within a process. It sees the 3D object from the perspective of 4D object.

only local behavior; it is the ability to bring together possible states, placing itself dynamically beyond the mere passage of time and mere internal possibilities of organization with respect to others. This property transcends specific moments by making reference to its own general and permanent properties. Since the past and the future of the structure are the structure itself, when it refers to the continuity of its states and the process of superposition that established them, it will make reference to itself. A structure that supports a system of superposition of states will have a self-referential nature.

Conclusion

In the present study, we attempted to find a way of inferring a referential process starting from concepts and elements of more basic order and autonomous existence in relation to an agent. The search for the bases that establish such process cannot start from an element or concept already representative, due to the circularity in which this attempt falls. In this way, we started from notions such as physical state, superposition of states, and causal isolation, in order to reach the idea of reference and, thus, the self-reference of a structure.

The definition of reference presented has a direct relation with that of causality, which is the complementary effect to the causal influence on a superposition system. The different influences of the causal history of a system are projected on a state and, therefore, the system makes reference to these influences. A state makes reference to the future moment of the system, because it is intrinsic to that system as well as the determining causal element in the direction of that future state in which it is contained. Beyond the simple causal succession when mapping internal causal processes, the mapping and superposing behavior becomes the object of the own information of each state. This way, the structure is characterized by a self-referential nature.

The problem of the homunculus, i.e., the observing element of the representation, can be circumvented by modifying the spatial by the temporal presupposition. When a structure is divided between the representation and the part to which it is representative, so that these aspects coexist simultaneously, both the mystical figure of the observer and the idea of representation arise as something not properly identified within the natural world. However, when we have a system that continually superimposes its manifestations in time, it becomes the element represented and projected into its future states, as well as for which these effects will be representative, i.e., it becomes the observing and the observed elements at the same time.

Appendix:

Causal overlap and self-reference: A summary

The purpose of this text is to present a summary of the theory of self-reference as a result of the superposition of a system's causal history. Self-reference is discussed here as an effect of the association between memory and causality. When we consider the eventual state of a physical system, we observe that different previous alternatives can lead to the same state. Since the means that constituted it are not intrinsic to it, it contains no elements to return to its previous state. In a system of causal superposition, however, each state contains the history of all the states that constituted it.

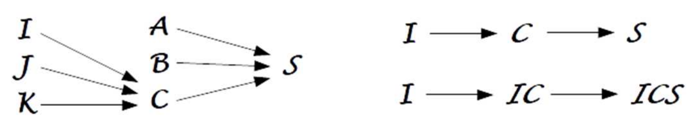

Figure 1. Different alternative states can precede a specific configuration. Here, we discuss the case of the previous states that constitute the current state, making the reconstitution part of their ongoing reality.

This occurs in systems of *causal delay*, or systems with memory. The evolution of this type of a system (a special case of causality itself) is followed by a delay in leaving the past states. Therefore, the system incorporates the changes, but by resisting the changes and confronting them with its tendency to remain unchanged, it will also simultaneously record the path from the past to the present.

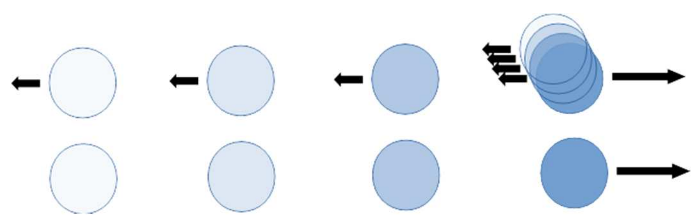

Figure 2. Representation of causal delay. Its direct consequence is that the dynamics of evolution become constitutive of the state as well.

A particular state will thus have the internal dynamics of this evolution. Each state will therefore have certain internal information:

a) The measure of change in each stage of the series, the reunion of an effect with its cause, and not just an alternative expression or another one of its possibilities

b) The determination of the accumulated state that will precede and succeed the other, or the ladder of relative pasts and futures.

The interdependence of cause and effect and the relationship between successions arise as extra properties of the dynamic. This information cannot be found outside of this dynamic, for in this case, the relationship between the previous and subsequent causes is lost; its past is only incidental. Only at this particular level can these properties emerge as such.

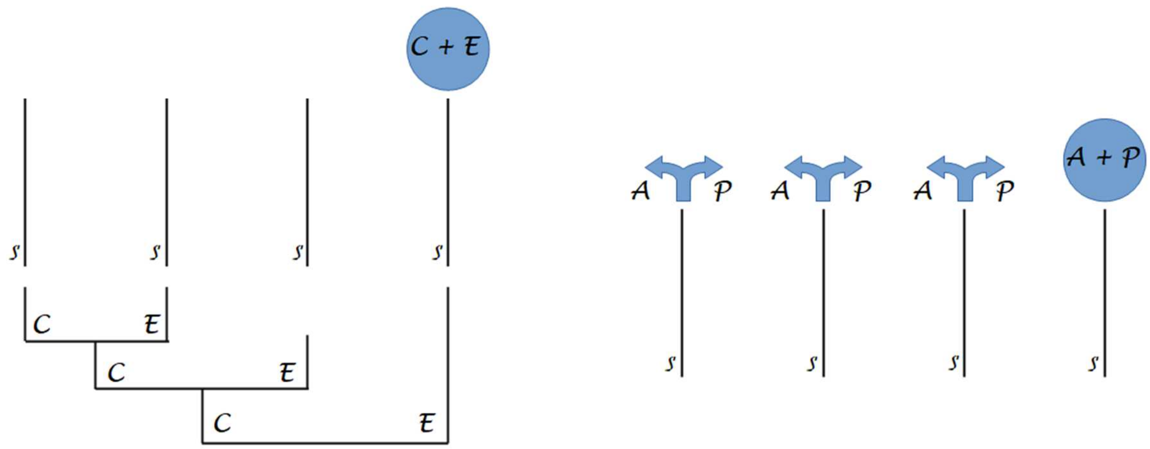

Figure 3. In the schematic above, S: state, C: cause, E: effect, A: antecedence, and P: posteriority. Properties that only exist in the dynamics of the transition emerge as state information.

This reasoning leads to the next step. If a state is superposed, it occurs amid the continuous accumulation of other, also overlapping, states, which in turn contain the generalization of succession and causality occurring between their stages. Thus, as each accumulates the properties of its constituents, by generalizing them (identifying or isolating properties that exist exclusively at each level of succession), they apply them to the series and to themselves. Since the first level abstracts a state, placing it on a continuum, on the next level, succession and cause and effect begin to apply to themselves.

Different cause-effect pairs are then causes and effects of each other, and a property common to any pair is generalized. The withdrawal of any cause-and-effect information from the series starts to apply to itself and thus becomes self-inclusive.

The same is true for succession as well. Succession occurs between states that have withdrawn their own succession from their series; thus, in the confrontation between them, this property is raised informationally as an element, independent of any succession, just as it is abstracted from particular states but not found in them.

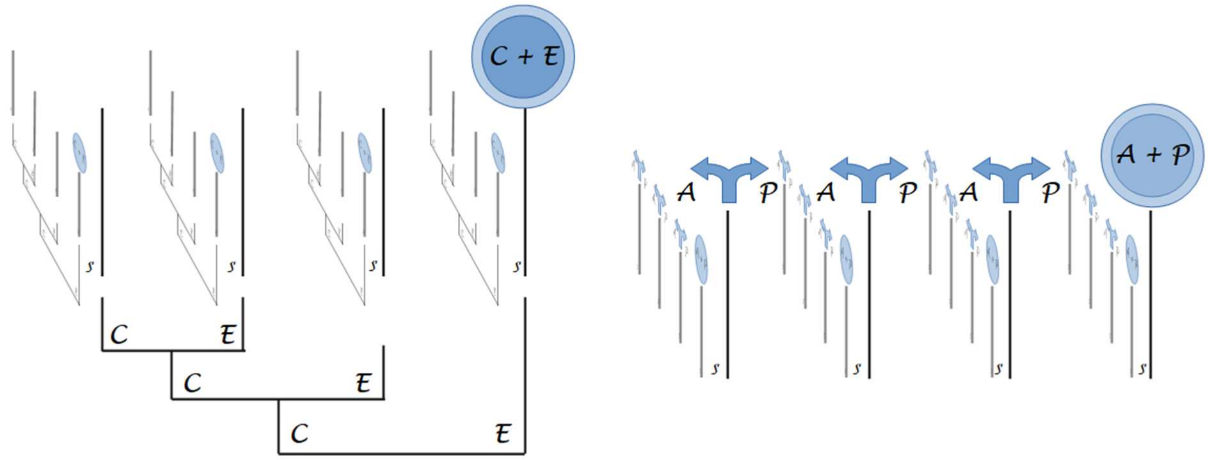

Figure 4. Representation of the generalization of properties as cause and effect and succession. Applied to themselves in the series, they become self-inclusive.

Reference is a projective capacity, or capable of extension from one instance to another. From a particular state, its perspective is enlarged to a succession; this in turn extends to the succession itself, regardless of what events it is given. In this step, the sequence then applies to itself, that is, the property's self-reference is a projection on the same level as it exists. If in the first level the new category that arises does not exist in its components, the self-referential properties need not be generalized by other levels since they generalize themselves.

These two levels of dynamics flow naturally from the causal delays themselves and coexist simultaneously. To understand this, just think of the decomposition of a state of memory. Memory is the reconstitution of the past from the present. As each previous state of memory has its own reconstituted series, memory is self-inclusive or it is formed of several states, each with its own memory. This is true for future expectations as well. Each state in the series has its own relative future ladder, and its projective relation to its immediate future is abstracted, independent of that of any particular moment.

If we consider a physical state as a brain state, we can describe it in three-dimensional space as a unified field of tensions. A succession of its states in time, accumulated in a superposed state, would hold the informational equivalent of a four-dimensional state at the first level. At the second level, that of generalization and self-inclusion, it would have the informational equivalent of the fifth dimension. The first level is expressed as an effective relation, the local reality of a cause-effect pair identified at a certain time. At the second level, a given overlap between states reveals a general potentiality, a general space for possible causal events.

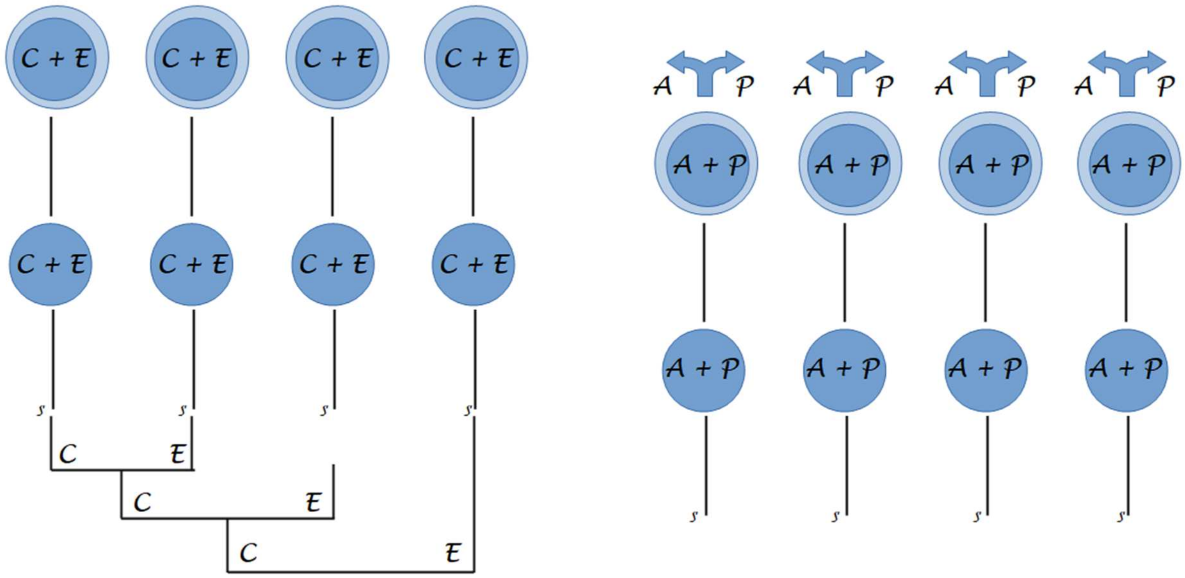

Figure 5. The two levels of dynamics are expressed simultaneously in the state, the generalized property, and its application to itself.

Thus, a specific causal orientation between states will only be informative when confronted with the general space perspective for possible links between states as a condition of their possibility. That is, it will be part of the physical information of the state of which it is one among others. The general space of all possible states, the structure, in addition to being referenced by the particular state, will include itself in each unfolding, being self-referential.

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