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Consciousness and brain mechanisms: Epistemological investigations between phenomenology and clinical neuroscience

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Abstract This paper investigates epistemological differences in the cognitive neuroscientific and phenomenological approaches to outstanding questions in psychiatry. We argue that clinical neuroscience provides scientific explanations in line with a mechanistic approach and describe several examples from computational approaches that illustrate what research on neural processing can tell us about psychiatric diseases. By contrast, phenomenology offers complex descriptions of experiential phenomena. Through a discussion of executive function and the related construct of impulsivity, we show that both cognitive neuroscience and phenomenology provide valuable types of explanation. Our focus on psychopathology also allows us to address some important epistemic differences between these two disciplines.
KEYWORDS: Phenomenology; Consciousness; Clinical Neuroscience; Computational Neuroscience; Cognitive Mechanisms

Riassunto *Coscienza e meccanismi cerebrali: ricerche epistemologiche tra fenomenologia e neuroscienza clinica* – Il presente lavoro propone di esaminare le differenze epistemologiche tra la fenomenologia e le neuroscienze cognitive riguardo dibattiti psichiatrici. Le neuroscienze cliniche saranno discusse in linea con un approccio meccanicista della spiegazione scientifica, mentre descrizioni fenomenologiche saranno proposte nel momento in cui complessi fenomeni esperenziali dovranno essere indagati. Un'interpretazione meccanicista delle neuroscienze cognitive sarà esemplificata ricorrendo ad alcuni esempi dagli approcci computazionali che si occupano di questi temi, i quali ci aiuteranno a definire cosa le ricerche sui processi neurali ci stanno dicendo rispetto alle sintomatologie psichiatriche. Questi argomenti saranno sviluppati attraverso una discussione che verterà sulle funzioni esecutive e il costrutto di impulsività a esse legato. Sarà discusso come sia le neuroscienze cognitive sia la fenomenologia possano fornire specifiche forme di spiegazione. Allo stesso tempo, si proporrà un'argomentazione che consentirà di discernere differenze epistemiche che caratterizzano i suddetti approcci, le quali potranno con più facilità emergere nel dibattito psichiatrico.
PAROLE CHIAVE: Fenomenologia; Coscienza; Neuroscienza clinica; Neuroscienza computazionale; Meccanismi cognitivi

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IF CLINICAL NEUROSCIENCE CAN BE considered a discipline based on science, it is possible to speak about it in terms of biological mechanisms and computational models. Empirical evidence constrains us to recognize specific patterns of cortical and sub-cortical functioning in correlation to determined psychiatric diseases and the resulting specific patterns of peripheral activation.[1] Cognitive and computational neuroscience can, therefore, be discussed in tandem when we are trying to explain what psychophysiological mechanisms are, and what role they have in psychiatric diseases.

Even though it is well known that phenomenology and other traditions[2] discuss psychopathology in terms of complex patterns, or *Gestalten*, this paper asserts that a focus on mechanistic explanations of symptoms could help us to understand how clinical neuroscience can maintain a specific role in psychiatric explanations. While it cannot be claimed that such an approach is entirely able to define and describe psychopathologies, it is important to discuss what clinical neuroscience can tell us about psychiatric diseases.

This paper will present the details of empirical studies in clinical neuroscience, and briefly introduce the phenomenological methods used to clarify these topics – investigating the essential form of the scientific explanation and interpreting it in line with the phenomenological description of the human experience.

1 The form of the scientific explanation

Our argument is grounded in the phenomenological tradition: we closely follow the method of Edmund Husserl, but also make reference to the phenomenological psychiatry of Jaspers and Binswanger.

The argumentation will remain coherent with the Husserlian definition of scientific explanation.[3] In the Husserlian thought, scientific knowledge is meant as a specific form of our experience. From this point of view, it can be easily said that the scientific description of events cannot coincide with the life-world *prima facie*.[4] This Husserlian position could also be understood in terms of the Aristotelian traditional distinctions concerning multiple forms of causality. It can be said that scientific knowledge takes place upon material causes;[5] indeed, in this paper we will claim that the nervous system can be considered the material substrate of low or higher-level processes, such as cognitions or affective processes.

Phenomenologists often resort to similar debates in order to propose a critical view of scientific knowledge, invocating fallacies of reductionism.[6] In this paper, scientific explanations will be recognized as a different form of knowledge, distinct from the experiential level described by phenomenology, without necessarily involving critical positions.

The legacy of the scientific method can be recognized within cognitive neuroscience methods, in line with actual epistemological debates in biological explanations[7] and neuroscience modeling.[8] As a result, we are able to determine which forms of explanation cognitive neuroscience is providing, since it is characterized by an amount of evidence that the traditional phenomenological approach cannot achieve.

The scientific attitude opens the human experience to methodical investigations of natural events, involving abstractive processes and causal-effect categories. Such a general assertion is important to better understand what forms of cognitions or processes cognitive neuroscience can explain, and how they relate to their organic substrates. In this sense, the scientific explanation of cognition in cognitive neuroscience must be defined as mechanical,[9] strongly involving a specific form of description of natural events in terms of neural mechanisms. However, the sense with which we denoted mechanisms is not exclusively mechanical, in line with modern biological debates, since it also involves a functional lexicon.[10] Indeed, we will underline the importance of the concept of "cognitive mechanism" in neuroscience as it is used in empirical studies and epistemological debates, and also meant as synonymous with "cognitive system".[11] This will enable us to recognize and defend a typical approach of the scientific explanation.

These details will be useful both to understand the role of a scientific approach in the study of psychiatric diseases, and also to identify differences between this and other approaches, such as those in phenomenology. When we are concerned with the complex existential-environmental constitutions of meanings, the phenomenological method allows us to better investigate qualitative interaction with the world. Paraphrasing Husserl, phenomenology remains in the philosophical fields, albeit as a rigorous science [*Wissenschaft*], so it cannot coincide with natural sciences.[12]

Cognitive or affective studies in cognitive neuroscience are instead strongly related to the ideations of models, and models can also be meant as paradigms with which experiments are developed.[13] As is typical in the natural sciences, within a model specific variables or entities are selected and isolated in order to manipulate them in an experimental way.[14] This approach is the primary means of investigating nervous system reactivity and correlating it with psychological constructs. Isolating specific cognitive functions can be an advantage when we mean to investigate specific nervous system reactions, even though it constrains us to work on specific temporal sequences and isolated variables. Not coincidentally, cognitive neuroscience is specialized in investigating phenomena with very fast temporal sequences,[15]

methodically excluding the narrative dimension. In this sense, the traditional definition of cognitive unconsciousness, in line with the distinction between personal or impersonal predicates,[16] is crucial to justify which type of phenomena cognitive neuroscience is specialized to investigate.

So if, in line with the phenomenology, we discuss cognitive neuroscience as a natural science, we can claim that its specializations in investigations of material causes can be related to the actual debates about cognitive mechanisms. In other terms, when we join in empirical approaches, we are not dealing with existential-cognitive functions[17] like the ones investigated in phenomenology. On the contrary, and also in line with the temporal domain of milliseconds with which experiments are often developed, the mind-brain system analysis allows us to reveal specific regularities. The timing of natural events is, indeed, an important feature in empirical studies, allowing us to define most of the mental phenomena described by neuroscience as unconscious.[18]

The concept of cognitive mechanism, or "cognitive system", as used in empirical research, allows us to discern the prerequisites for understanding mind-brain regularities, although at a different level to the explanations offered by very complex forms of human experience. Once we are involved in investigations about the stream of consciousness, we cannot approach topics like psychiatric diseases with only the scientific form of explanations, given their non-material essence.[19] The description of the essences of human experience opens us up to a new ontological domain, the life-world in traditional terms,[20] which requires a different epistemological approach to be described. In any case, this claim does not imply that such complex existential features exclude the importance of implementing material substrates.

2 Computational psychiatry

The aim of preserving a specific role for research in cognitive neuroscience, with its mechanical features, can be better understood by proposing an interpretation of modern evidence in computational neuroscience, with particular reference to computational psychiatry.[21] Although it is beyond the scope of this paper to discuss in detail the mechanical nature of the neuroscientific explanation, a reference to computational studies should help us to exemplify this topic.

Computational psychiatry, as well as most empirical studies in cognitive neuroscience, is strongly related to the development of tasks and models through which specific functions are isolated.[22] Such a methodology can be considered reductive, especially when psychiatric debates are introduced.[23] A common complaint is that it is very difficult to define psychiatric categories by isolating a specific neural network, and this paper would agree with this stance. However, the aim of the present paper is not to confute a strong biological explanation for psychiatric diseases, but to define what psychophysiological explanations can offer us.

According to cognitive modeling, most of the mental phenomena described by cognitive neuroscience can be translated into computational algorithms, which are neither personal nor existential, involving mechanisms necessary to implement the correct functioning of the mind–brain system.

The nervous system can be examined with specific strategies, and these strategies methodically exclude complex temporal sequences, focusing instead on the neural substrates of specific functions. However, in order to maintain the concept of "psychophysiology", it is necessary to point out that the passage from the brain to the mind necessarily sets aside a detailed investigation of the consciousness with the environment.

From a different point of view, though, the phenomenological notion of "condition of possibilities" could also be applied in cognitive neuroscience, involving a different meaning. In this sense, the functioning of the nervous system can be defined as the main prerequisite – a condition of possibility – to developing very complex environmental interactions.

3 Toward a scientific approach in psychiatry

It will be assumed that specific psychiatric categories cannot be recognized within investigations of the brain system, for the same reason that we cannot recognize specific patterns of personality by investigating the psychophysiological domain in an isolated way. It is no coincidence that personality and psychopathology are strongly linked,[24] given their "experiential properties", as we will discuss in the following paragraphs.

In line with contemporary debates about the network approach in psychiatry,[25] it can be assumed that investigations of symptoms show a stronger heuristic approach to define different psychiatric diseases. Different symptoms interact with each other, and such a claim shows causal relations emerging without the need to know the specific neural correlates that explain them.

These high-level assumptions of psychiatric disease seem to be very critical regarding neuroscientific evidence, since cognitive functions, as well as affective processes, are meant in cognitive neuroscience as "mechanisms", both in epistemological and empirical studies. Indeed, typical empirical approaches resort to specific tasks or protocols in order to investigate how different neural phenomena, such as synaptic transmissions or neural network activations, characterize specific cognitive "endophenotype",[26] and how the latter can be correlated to psychiatric diseases.[27]

Of course, when this approach is used to define general psychiatric categories, such as schizophrenia or major depressive disorders, the threat of biological reductionism is more apparent. For these reasons, it is useful to point out that investigations about specific "symptoms" characterize most of the biological investigations of psychiatric diseases. The role of executive functions concerning psychiatric categories in proposing a focus on specific symptomatologies, rather than on general categories, will be discussed in greater detail in order to exemplify this as the main heuristic approach in clinical neuroscience.

The correct functioning of executive functions[28] can be related to underlying mechanisms supported by the pre-frontal cortex[29] (PFC). In this sense, the PFC can be meant as the cortical areas mainly involved in elaborations of information to achieve complex goal-oriented behaviors.[30] It is no coincidence that impaired functioning of the PFC, so the executive functioning, could be inversely correlated to impulsive behaviors.[31] In any case, empirical literature shows how impairments of the PFC are strongly related to numerous different psychiatric diseases:[32] so, it is not possible to define a psychiatric category by only defining the functioning of the PFC with the related neural networks.

This paper will point out that a major advantage in the scientific explanation can be reached if we describe how the functioning of the PFC, proposed as an example, can provoke the emergence of a specific personality or psychiatric traits, such as impulsivity. If we mean impulsivity in this sense, as a specific trait of a general category, the neuroscientific approach can help us to better understand how the nervous system works and how this functioning can be related to psychiatric diseases.

Speaking about psychophysiological mechanisms makes it possible to investigate how specific neural networks or synaptic transmissions are impaired in psychopathology. For these reasons, we propose that the scientific investigation of traits or symptoms is the best approach for understanding nervous system abnormalities in psychiatric diseases, without the need to reduce the experiential level to the biological or propose strong criticism of the scientific method.

Of course, such an epistemological assertion does not resolve the complex debates in the empirical field. Continuing our example: there are empirical or computational investigations about the role of specific neurotransmitters in the PFC which are important to described psychiatric traits, like the functioning of this cortical area in impulsivity.[33] Moreover, despite important evidence, the scientific community itself is well aware that a model is not a complete description of an event and, for instance, it is well known that an important neurotransmitter in the pre-frontal cortex – serotonin – involves mutual relation with others within the same region, such as dopamine.[34] Furthermore, the functioning of the PFC in relation to impulsivity can be further developed by relating it to further psychological constructs, such as aggression[35] or cognitive control impairments, and so on.

In a few words, empirical studies are involved in important debates about the functioning of the nervous system in relation to psychological constructs, and these topics cannot be resolved in an epistemological debate. On the contrary, epistemological arguments are essential to understand how empirical evidence can be interpreted in relation to higher level phenomena, such as psychiatric diseases.

Despite the involvement of multiple psychophysiological mechanisms in different cases, it is clear that impulsivity can be interpreted as a specific component of different diseases. In other words, impulsive traits are not sufficient to define a personality or a psychiatric disease, but they can be meant as components of the latter, and the same goes with other psychological constructs such as aggression. It is no coincidence that the DSM-5 describes aggressive or antisocial behaviors as common to both schizophrenia and bipolar disorders, so these psychiatric traits cannot be considered as definitive of either disorder.

In line with the mechanical lexicon of cognitive neuroscience, this paper proposes that there is a greater advantage to discussing psychiatric diseases by focusing on their symptoms, rather than on general categories. Such an assertion can be considered in line with computational neuroscience, corroborating the importance of the mechanical properties we are discussing.

Computational algorithms have, for instance, been developed to simulate the normal functioning of the PFC and the executive functions implemented by it, and they also have been applied to simulate specific psychiatric symptoms. In literature, different models of working memory, learning[36] or compulsive behaviors[37] can often be found. In line with the scientific method, such models are able both to isolate specific functions with their related outcomes and to simulate the cortical or subcortical areas involved in these functions (or "layers" in technical terms[38]).

Given the possibility to develop computational models of specific psychophysiological functioning, it should not be difficult to recognize the mechanistic explanation involved in such strategies. In the final section, we will introduce an example of a working memory model – a typical executive function – to better explain this approach. In the meantime, it is important to introduce the phenomenological approach, in order to explain why these types of models are not powerful

enough to describe either the human experience or, therefore, the psychopathology.

4 Phenomenology and psychiatry

Compared to the lexicon of cognitive neuroscience, a focus on the phenomenological approach easily shows an important difference when conscious activities are introduced. In line with neuroscience literature, it is well known that brain correlations are mainly investigated in terms of executive functions, such as planning or inhibition, attention, different forms of memory, and so on. It should be easy to recognize that such definitions involve general functions if we compare them to the lexicon and descriptions of phenomenology, in particular with the analysis of mental states [*Erlebnisse*].[39] Phenomenology describes the human experience by investigating the qualitative contributions of each mental state and revealing specific modalities and objects that each class can "constitute". The same assertion applies to "intentionality"; indeed, Husserl also described such functions in terms of intentional processes.[40]

We anticipated that the mind-brain system could be interpreted as a pre-requisite for the complex sequences of mental states in our conscious life, even though we will now propose that investigations of the brain system cannot explain our conscious experience. In traditional terms, the phenomenological level possesses ontological independence from the psychophysiological domain, even though the latter can affect the former in several ways.

We will discuss how phenomenology is specialized in qualitative investigations of mental states and how this method allows us to maintain a certain type of functional lexicon, albeit resorting to an approach that could in no way be defined as mechanistic.

The phenomenological approach is based on the concept of consciousness with both methodical and ontological assumptions. A phenomenologist would speak about the "I" in a different sense, a "pure I" [*Reine Ich*] or the empirical one,[41] nonetheless, such a distinction can be simplified by referring to the consciousness and the Self, in line with the contemporary literature.

The development of the Self is a very important topic for understanding psychopathology, although the investigation of the Self is just one of many topics within phenomenological research. When a phenomenologist speaks about consciousness, his references are mainly directed to intentionality, meant as the essential property of consciousness.[42] In a few words, we cannot understand how consciousness organizes our Self-experience if we do not focus on the modality with which each intentional function, or mental state, is directed toward specific objects.[43]

5 Mental states from a phenomenological perspective

We can exemplify such an approach by briefly speaking about perception and different mental states, such as representations, beliefs and judgments, from the phenomenological perspective. This description will help us to clarify the concept of "mental states" in a few words, and to delineate assumptions in order to define psychopathology.

The investigation of "perceptions" is one of the most important epistemological features in phenomenology. All human experiences begin with perceptions, and perceptions concern how we relate and interact with "things". In this sense, we cannot define perception as a "psychological construct" in phenomenology. Of course, it is worth mentioning that there is a large corpus of empirical psychological studies on perception. However, a phenomenologist would define such research as engaged in definitions of *components* of perception, giving us the idea of internal elaborations. The phenomenological concept of perception instead points out the direct relation to external things,[44] upon which the subsequent cognitive processes are implemented.

A discussion about representations and judgments should clarify such a claim. If we consider our approach to external objects with only perceptive features, we will not recognize them as categorical objects. In order to discern predicates or conceptual features about an object, we need different functions, such as representation and judgment, both of which are essentially different from perception.

The representational level can be proposed as the simpler form of our experience. Representations denote products of our iterative approaches to the world or specific objects, including physical-sensory objects or another living being. In this sense, the qualitative relation between perceptions and representations is very important to understand how our elementary layers of experience take form. Different properties of representations are essential when more complex environmental interactions are involved, as it is with the role of beliefs or anticipations. In order to anticipate simple or complex events in our environments, we need specific representations as "conditions of possibilities" to correctly process them. For instance, the traditional concept of "affordances" can be observed from a phenomenological point of view, in relation to this discussion. When our experience involves the ability to anticipate the morphological features of an object or our possible actions in relation to it, we require both a representation of its sensorial features as well as an anticipation of our sensorimotor abilities. It is unsurprising, therefore, that along with representations of objects, the sensorimotor representation

of our body can be defined as an integrating part of our experience.

A further level of complexity can be introduced relating to judgments, which should clarify the aforementioned premises. Unlike representations or beliefs, judgments require logical-linguistic activity to be defined as such. Judgments introduce conceptual or abstractive skills into our field of interactions, with which we learn to process very complex expectations about the environment, and also to reason about the environment in an inferential way.

The introduction of logical skills should be discussed in phenomenology when we are dealing with the "theory of knowledge". From a psychopathological perspective, we can simplify such a topic by observing a specific normative level that characterizes them.

Often in psychiatry, pathologies are discussed as being strongly related to normative contents.[45] Such an assertion can be better investigated resorting to the theoretical definition presented above, introducing a particular focus on the concept of "normative" and "contents" of specific functions. In psychiatric disease, speaking about normative contents is related not only to logical impairments but also to fallacious beliefs or delusions. We are interested in both elements of such a claim: the normative and the content levels. Normative features can be meant in a very different sense, but in psychopathology we can mean them as subjective adjustments to social norms or collective thoughts, which thereby raises an issue by proposing a biological view of them. Cross-cultural studies about the genesis of the Self can be read in line with these assumptions,[46] through which it is possible to understand why psychiatric debates cannot be easily resolved in natural terms alone.

It is important to explain the definition of "content". As we have claimed, phenomenology is strongly interested in the type of objects that each mental state can grasp and in which modality this occurs. For this reason, social norms, or norms in general, cannot be defined in psychological terms alone. Of course, different psychological processes participate in generating or postulating such collective entities, but they are generated by wide sequences of individual or intersubjective reasoning about them. Thus, contents are obviously elaborated through different processes, but they are also external objects once they are "constituted" – elements of thought and collective products.

In line with Husserl, we define the field of judgments as the strong normative source, which he associated with the concept of "reason".[47] This necessarily opens up debates about epistemic values. From a psychiatric perspective, however, we are not only speaking about correct inferences in making experience, since such processes often evolved unconsciously through passive syntheses in traditional terms. For this reason, judgments have a positive connotation in phenomenology, a sequence of processes can acquire such a meaning when a path of reasons has been explicated. We can, however, better understand such a claim by comparing it with the concept of belief. Indeed, false or pathogenic beliefs can possess either episodic or semantic formats, but they cannot be defined as judgments until their "truthfulness" has been investigated in an epistemic way.

False or pathogenic beliefs are fundamental components of psychopathology in the way that they concern our processes to "recall" or develop ideas about our social worlds, and this topic can be better understood by keeping these phenomenological premises in mind.

6 The constitution of the Self by consciousness structures

Our brief introduction to the phenomenological approach was needed in order to discuss consciousness in a general way. This should help us to avoid confusing consciousness with other terms, especially with the Self or the cognitive unconsciousness. Of course, in common sense language, the Self is an integrating part of our consciousness of the world, even though it should be defined as a specific component of our experience. In a different sense, cognitive unconscious processes, or "computational" processes, are also plausibly involved in our daily experience, even though they cannot entirely explain human consciousness.

Phenomenological investigations of consciousness reveal how different mental states can grasp objects with specific modality, with qualitative descriptions and different references to epistemic values. In this sense, we developed the experience of our external world by interacting with it, making it not only a perceptive field but also a representational or believed one. So, detailed descriptions of mental states, along with their features or essential forms, are needed to understand how the most complex forms of experience are constituted.[48] Furthermore, when we speak about the Self, we need to resort to the *same* mental states and the same consciousness structures, albeit directed to a different target: ideas about ourselves.

For instance, perceptions easily show a qualitative difference when they are directed to the Self instead of to external objects. They do not allow us to perceive the Self at all, they can only perceive the body from the first-person perspective, but the body alone is not the Self and requires other functions to be constituted.

Going straight to the conclusion of these premises: the Self is a representation, one of the more complex in the human experience, and it can be generated in the same way that other representations take form, despite revealing specific ontological properties.

Consciousness processes allow us to experience the world as conditions of its possibilities, but, at the same time, they allow us to generate ideas of ourselves, to constitute our "narratives" in contemporary terms.

7 Mental states within the genesis of the Self and psychopathology

The proposed distinction between consciousness and Self will become clearer in this section. In order to distinguish neural explanations from phenomenological ones, it is very important to advocate the qualitative role of consciousness in phenomenology to explain how personality and psychiatric diseases are constituted and characterized by mental states.

We need to focus in particular on *sequences of mental states* to understand our Self experiences. In the previous section, we isolated different mental states, including beliefs or judgments, to describe their essential forms. If, however, we focus our attention on modalities in which our Self is constituted, we need to focus on their mutual relations, where both cognitive and emotional attitudes are involved in the *same experience*.

We will not speak directly about the emotional features of Self-experience, but it can be said that along with our cognitive approaches to the world, for instance through beliefs or anticipations, emotional states are certainly involved in constituting the Self.[49] For example, when we speak about our subjective abilities, we are recalling past information about events along with their affective correlates. My past failures can be strongly related to emotions like frustration, and my future anticipation about my abilities can involve the fear of failure. This example demonstrates how a phenomenologist does not describe the genesis of personality and psychopathology in organic terms, but investigates mutual relations between different mental or emotional states. Another example: I can judge the taste of a fruit with negative emotional connotations. If the *same judgment* is directed to an idea that constitutes our Self, a negative judgment will be *felt* involving a sentimental disposition. In conclusion: the taste of a fruit ends up with a withdrawal that depends on the direct sensorial stimulation, while the feeling about one's Self depends on the causal effect that the exemplified judgment exerts on ideas and representations concerning the subjectivity.

A detailed investigation of mental states can be applied to clarify typical topics about the development of a specific personality or personal history. Indeed, the same theoretical tools can be used to understand how psychiatric diseases are characterized, for instance within the topic of pathogen beliefs.

A phenomenologist would say that beliefs are mainly concerned with "possibilities" rather than with "reality", and such an epistemological assertion is very important to understand the genesis of psychopathology.

In order to explain specific psychiatric diseases it is important not to confuse false beliefs with judgments, since they are related to different epistemic values. In other words, the "possibility" would be confused with the "reality", and such cognitive processes necessarily involve different emotional reactions and experiential organizations. In *General Psychopathology*, Jaspers describes patients who express utterances about the end of the world: when similar cognitions are expressed they can be defined as *certain* about catastrophic events. Similarly, Binswanger[50] investigated delusions with an analogous approach: revealing qualitative differences when a delusion is not founded on a real event but developed in a fantasized way. Patients confuse imagined events with real ones, without engaging themselves in evaluating the validity of such assertions. The reality of the represented events would be evaluated as wrong if it was investigated from an intersubjective point of view; nonetheless, patients define such cognition as real, with subsequent existential impairments.

In the following sections we will propose to maintain the complex approach of phenomenological psychiatry, while trying to defend a specific role for the neuroscientific evidence introduced.

None of the forms of phenomenological explanation have material-mechanistic properties. Of course, the body is a material thing, but we make experience of it through cognitions, or "noetic processes" in Husserlian terms, making it a lived body [*Leib*]. In any case, the noetic-cognitive level is constituted by sequences of processes, each one with different qualities and mutual relations. This gives us the idea that the constitution of the Self-experience, as well as the genesis of the psychopathology, has not only a material basis in the phenomenological perspective, but also "ideal", as sequences of ideas, representations, judgments about ourselves, and so on. It is easy to see how a similar approach cannot coincide with the scientific explanation, and therefore it is necessary to discuss how discoveries of "cognitive mechanisms" can communicate with the phenomenological approach.

8 The case of executive functions in psychopathology between phenomenological descriptions and cognitive neuroscience

It has been assumed that cognitive mechanisms are efficiently described by both psychophysiological and computational approaches and such descriptions have been related to the traditional form of scientific knowledge, also definable as a specific "ontological region", to use a Husserlian term[51] – recognizing their heuristic importance, even while distinguishing them from phenomenological descriptions.

Resorting to the phenomenological approach, it

can be said that organic substrates cannot entirely determine the conscious experience; consciousness is not material and does not follow mechanistic regularities.[52] It can be also said that the correct functioning of the nervous system, in particular of the prefrontal cortex (PFC), has the primary role of allowing us to reason or reflect about personal events, so it can indirectly affect the conscious experience.

It has been already said that the human experience is organized through sequences of mental states, and we pointed out that sequences of mental states do not directly follow natural events. In other terms, how we organize our thoughts or develop reasons or values strongly depends on the "Will",[53] and the latter concept, as defined in phenomenology, cannot simply be defined as "natural".

On the contrary, cognitive neuroscience investigates the brain functioning of an individual at a specific time of their life, through specific experimental settings, and so on, supplying us with discoveries about nervous system mechanisms. So, even though neuroscience does not describe how psychopathology is developed from a conscious or existential point of view, it can describe how specific neural network functioning can provoke specific traits of a disease.

This topic can be developed by returning to the important debates in clinical and computational neuroscience mentioned above. It is worth highlighting that recall, updating, and similar functions are strongly related to pre-frontal functions, such as working memory.[54] In other words, these high-level functions can be understood as the ability to control bottom-up responses or exert Self-control. Even though our conscious experience of the surrounding context is too complex to be understood with the psychophysiological domain alone, it is possible to agree that the correct functioning of the PFC plays a major role in allowing us to stop automatic responses or activate goal-oriented behaviors, but it is necessary to specify in which sense.

Of course, speaking about abnormal activities of the PFC with the related executive functions does not help us to clearly define psychiatric categories, though it can help us demonstrate that specific symptoms have organic correlates and mechanical functioning.

The correct functioning of the PFC can, in line with the former premises, be generally defined as the *prerequisite* to the ability to exert control, even though strategies to control our environment are very complex and varied at the experiential level. If we agree with empirical studies about the common involvement of PFC impairments in very different psychiatric diseases, it is necessary to claim that the organization of thoughts in such diseases requires qualitative descriptions in order to be better understood.

For instance, major depressive disorder and schizophrenia both involve an impairment of the PFC, even though such psychiatric categories show very different properties in qualitative descriptions. In other words, both the diseases could be characterized by an impairment in the neural processing within the PFC, but how the experience is organized in both cases is markedly different if investigated with phenomenological descriptions, which analyze the relations between mental and emotional states.

Major depressive disorder involves a lot of different symptoms, but we can specify one that is typical: rumination. Often rumination involves wrong judgments about the world, but in particular it involves beliefs that change constantly during the day. We specified that mental states are related to each other, and such a claim is important to understand these phenomena. So, if I change my belief about a significant event for myself, I immediately need to reason about new predictions or consequences, and the latter can change my emotional attitude and so on. The lack of environmental investigations of my belief necessarily involves new elaborations of our cognition, which needs to be analyzed with references to modalities in which personal beliefs are organized or expressed.

As has been discussed, phenomenological descriptions are also related to normative debate, so the sequences of mental states with which we investigate the world are not only psychophysiological phenomena, but also mental acts that need to be investigated in relation to their epistemic values and contents. In daily life, however, normative investigations are not always involved. The development of our personality, along with developments of diseases, strongly depends on wrong inferences or beliefs, and the correctness, or adjustment, of these mental states cannot only be explained in the psychophysiological domain.

The same example can be further developed with other symptoms, such as delirium and similar afflictions in schizophrenia. Even in this case, we will not qualitatively distinguish such concepts through an organic investigation, since the normative level requires environmental investigations to be clarified.

Delirium can be interpreted as *judgment impairment*, so a more severe level compared to beliefs or references to episodic memories. Our semantic-conceptual skills are needed to correctly codify contextual knowledge, social rules, and so on, but an isolated analysis of them is not enough to discern wrong judgments.

When judgment skills are severely impaired, patients can, of course, be recognized with *wrong patterns of thought.* Anyway, an epistemic value like "wrong" requires a different level from the psychological one to be defined: neural events are necessary to implement the information through which we develop our judgments, but judgments

require correlations with the world to be evaluated, or "transcendental correlation".[55]

In other words, the way in which we distinguish rumination from delirium is based on the distinction between beliefs and judgments. While the beliefs involved in rumination are related to "possibilities", judgments denote "certainty", and the latter property is the one that constitutes delirium. Schizophrenic patients, for instance, are not afraid that some of their beliefs can be "verified", they are "certain" that something is "true".[56]

In conclusion: the lexicon of mental states allows us to qualitatively describe how our investigations about the world are characterized, and how specific diseases take form. From now on, it is necessary to keep in mind the importance of these descriptions, while also appreciating the role of studies about the nervous system functioning. Since it has been asserted that the exemplified symptoms are strongly related to reasoning and similar processes, it can be also said that impairments in pre-frontal functions can also be related to the latter abilities.

It has been already stated that the functioning of the PFC is correlated with the concept of executive functions. So, in line with related theories, it can be said that in order to correctly reason about events we do not only need to recall determined propositions or concepts, but we should also maintain or update our concepts. The organization and development of different concepts can refer to functions such as recall or updating in working memory, and if such processes do not work efficiently it is possible that correct premises are not involved in reasoning.

Despite the psychological lexicon characterizing these debates, we will maintain a mechanical approach to explain them. For instance, working memory models are interesting to explain such an interpretation: helping us to better understand why neuroscience is focused on understanding correlations between psychological constructs and neural processing. Resorting to a concept like "working memory" (WM) – a main component of executive functions – helps us to investigate determined neural events.

A WM model[57] will be briefly exemplified to better clarify these positions. In line with this model, the PFC can be meant as a processor, within which the contextual information of rules about a task is implemented and maintained. If we set aside how reasoning or planning are developed in daily life, it can be said that a similar functioning of the PFC is required to correctly organize our actions or choices in each case. PFC neurons remain activated when specific information about stimulus targets or task rules are required, and the concept of working memory allows us to discover such neural events. Similar functioning of the PFC, in particular when rules are "maintained", is also evident in neurophysiological studies.[58]

As has been already said, computational models are, for these reasons, apt to describe the brain as a "complex processing machine"[59]; moreover, this claim helps us to ensure that we do not reduce the mechanisms of the brain to the structures of consciousness. The example of WM we proposed helps us to understand pre-frontal functions as elaborators of information. The executive functions concept allows us to understand how neural networks work to maintain activated neurons that encode high-level information. In this sense, our ability to control our thought, on a psychophysiological level, is efficiently described denoting the role of the PFC as a managing area of neural firing, from which the concept of "control" arises.

Even though we will not discuss in this paper "why" the brain system works in a different way in specific psychiatric diseases, we can, however, affirm that an impairment in the correct neural processing within the PFC, for instance, can explain the emergence of impulsive or aggressive traits.[60] In a few words, impulsivity strongly depends on the primacy of "bottom-up" responses, where functions like updating, maintaining, or inhibitions are severely impaired. So, a similar functioning of the nervous system can be recognized in different high-level psychiatric categories.

Thus, the executive function modeling allows us to postulate common mechanical causes that encompass different psychiatric diseases, along with the neural descriptions. For instance, even though impulsive traits can be meant as traits of a specific psychopathological category, such as schizophrenia or bipolar disorders (both of which are described by the DSM-5 as characterized by impulsive behaviors) through cognitive neuroscience it is possible to affirm that the emergence of these traits is provoked by a specific functioning of the PFC and related neural processing. In a few words: clinical neuroscience allows us to predict how the nervous system works in relation to specific traits characterizing psychiatric diseases, even though it does not help us to define or qualitatively describe such categories. For the latter aim, in this paper, the phenomenological approach has been proposed. Indeed, it has been recognized that when we need to define or describe the emergence of concepts, rules, norms, values, and so on, a phenomenological attitude is required.

Epistemological investigations about the nervous system studies, on the other hand, can help us to better understand empirical evidence. So, neural mechanisms that allow us to organize or recall past information, as encoded in neurons, can be discussed along with phenomenological descriptions. Such an assertion does not reflect the necessity to reduce human conceptual or inferential skills to psychophysiological mechanisms.[61] For the aim of the present paper, it is sufficient to say

that the nervous system needs executive functions to correctly organize past acquired information or to activate other neural networks that allow us to predict future outcomes. In order to qualitatively describe developments of our inferences or utterances a complementary approach is needed.

Elementary mechanisms of information processing are, therefore, defined as prerequisites for the correct organization of our thoughts, even though we have already said that mental processes are not simply brain processes, since they allow us to investigate the external worlds, involving very complex constitutions of meanings or epistemic values. So, *the normal functioning of the prefrontal cortex could be postulated as an important prerequisite for the correct development of reasoning*, allowing us to correctly process the epistemic values of our beliefs or utterances. In any case, even though the PFC functioning can be understood as a necessary brain mechanism to exert such abilities, the normative and experiential level can be preserved without risk of reductionism within psychiatric debates*: truth values or complex concepts, like social norms, need environmental interactions to be constituted* in order to characterize the human experience. In this sense, the correctness of an utterance cannot be solved using only a psychophysiological perspective, we should instead refer to our logical or intellective skills to understand such a topic.

In other words, it is necessary to stress that the development of reasons or adjusted contextualized thoughts requires a very complex *reciprocal interaction of mental states and external phenomena* to be explained. While *we cannot say that associations between ideas, rules or propositions have specific organic correlates, we can, however, say that each form of reasoning requires the involvement of specific cognitive mechanisms to be elaborated*, such as working memory or cognitive control, both of which are mainly bounded to the correct functioning of the PFC and the related neural patterns activations.

9 Conclusions

This paper affirms that cognitive neuroscience is specialized in investigating the mind-brain system in a mechanistic-organic way, and this approach has been meant as a main component in understanding the basic functioning of the nervous system. In particular, the isolation of specific symptoms is very important to understand how highly complex psychiatric diseases are characterized by organic properties, and we referred to the concept of executive functioning, or control, with the inversely correlated construct of impulsivity, to corroborate this thesis. Neuroscientific descriptions of cognitive functions allow us to investigate the nervous system, and the neural lexicon can be considered essential to explain how specific cortical areas, such as the PFC, works. The processing of information is essential to the development of our reasoning, and functions like maintaining or recalling past information can be defined as the main prerequisites to proceed with further inferences, or to develop premises for our reasons.

Despite defending the importance of clinical and computational neuroscience when we resort to it to explain specific psychiatric symptoms or traits, we have also defended the phenomenological approach, since both methods should work together. The genesis of psychopathologies, or the qualitative descriptions of them, requires a detailed investigation of mental states along with their reciprocal and environmental constitution. Indeed, clinical and computational neuroscience can be considered specialized in investigating specific mechanical regularities of the nervous system, proposing correlation with specific psychological constructs; however, a phenomenological approach is required where we need to understand how specific symptoms are experientially organized by a conscious perspective.

Notes

[1] Cf. I. Singh, N. Rose, *Biomarkers in psychiatry*.

[2] Enactivism and neurophenomenology both involve philosophical interpretations that would accept such a claim. In any case, in this paper we will focus on the phenomenological method, as exposed by Husserl, focusing on the specific epistemological features that characterize this approach compared to the aforementioned interpretations.

[3] Cf. E. Husserl, *Ideas pertaining to a pure phenomenology and to a phenomenological philosophy, Second book*, pp. 3-27.

[4] Cf. E. Husserl, *The crisis of European sciences and transcendental phenomenology: An introduction to phenomenological philosophy*, pp. 375-384.

[5] Cf. A. Ales Bello, *Consciousness and hyletics in humans, animals and machines*.

[6] Cf. L. Binswanger, *Being-in-the-world: Selected papers of Ludwig Binswanger*.

[7] Cf. R.W. Batterman, C.C. Rice, *Minimal model explanations*.

[8] Cf. D.M. Kaplan, C.F. Craver, *The explanatory force of dynamical and mathematical models in neuroscience: A mechanistic perspective*.

[9] For more information cf. C.F. Craver, W. Bechtel, *Top-down causation without top-down causes*.

[10] In a few words: low-level entities make it possible to implement functions within higher levels.

[11] Cf. F. De Brigard, *Cognitive systems and the changing brain*.

[12] Since phenomenological descriptions are not just concerned with natural entities, it becomes difficult to define experiential concepts, such as the ones involved in psychiatric disorders, just in natural genres terms: M. Casali, *Generi psichiatrici come HCP: un nuovo approccio al dibattito discreto/continuo in psichiatria*.

[13] Cf. M.J. Farah, P.R. Wolpe, *Monitoring and manipulating brain function: New neuroscience technologies and their ethical implications*.

[14] Cf. R.S. STUFFLEBEAM, W. BECHTEL, *PET: Exploring the myth and the method*.
[15] Cf. S. GALLAGHER, *New mechanisms and the enactivist concept of constitution*.
[16] Cf. M. MARRAFFA, A. PATERNOSTER, *Functions, levels, and mechanisms: Explanation in cognitive science and its problems*.
[17] For the same reason, cognitive neuroscience does not directly examine intentionality and the genetic constitution of objects, cf. E. HUSSERL, *Ideas pertaining to a pure phenomenology and to a phenomenological philosophy, Second book*, pp. 181-194.
[18] Cf. J.R. SEARLE, *Mind: A brief introduction*, pp. 241-243.
[19] Cf. J. PARNAS, L.A. SASS, D. ZAHAVI, *Rediscovering psychopathology: The epistemology and phenomenology of the psychiatric object*.
[20] Cf. E. HUSSERL, *The crisis of European sciences and transcendental phenomenology: An introduction to phenomenological philosophy*, pp. 43-44.
[21] Cf. X.J. WANG, J.H. KRYSTAL, *Computational psychiatry*.
[22] Cf. P.R. MONTAGUE, R.J. DOLAN, K.J. FRISTON, P. DAYAN, *Computational psychiatry*.
[23] Cf. D. BORSBOOM, A.O. CRAMER, A. KALIS, *Brain disorders? Not really: Why network structures block reductionism in psychopathology research*.
[24] Cf. T.A. WIDIGER, *Personality and psychopathology*.
[25] Cf. D. BORSBOOM, A. O. CRAMER, A. KALIS, *Brain disorders?*.
[26] Cf. T.V. WIECKI, J. POLAND, M.J. FRANK, *Model-based cognitive neuroscience approaches to computational psychiatry: Clustering and classification*.
[27] Cf. H.R. SNYDER, A. MIYAKE, B.L. HANKIN, *Advancing understanding of executive function impairments and psychopathology: Bridging the gap between clinical and cognitive approaches*.
[28] Cf. A. MIYAKE, N. P. FRIEDMAN, M.J. EMERSON, A.H. WITZKI, A. HOWERTER, T.D. WAGER, *The unity and diversity of executive functions and their contributions to complex "Frontal Lobe" task: A latent variable analysis*.
[29] In this paper we will simplify the role of the prefrontal cortex, and we will not discuss further subdivision of this cortical areas.
[30] Cf. E.K. MILLER, J.D. COHEN, *An integrative theory of prefrontal cortex function*.
[31] Cf. W.K. BICKEL, D.P. JARMOLOWICZ, E.T. MUELLER, K.M. GATCHALIAN, S.M. MCCLURE, *Are executive function and impulsivity antipodes? A conceptual reconstruction with special reference to addiction*.
[32] Cf. H.R. SNYDER, A. MIYAKE, B.L. HANKIN, *Advancing understanding of executive function impairments and psychopathology*.
[33] Cf. M. OUZIR, *Impulsivity in schizophrenia: A comprehensive update.*
[34] Cf. D. SEO, C.J. PATRICK, *Role of serotonin and dopamine system interactions in the neurobiology of impulsive aggression and its comorbidity with other clinical disorders.*
[35] Cf. E.S. BARRATT, M.S. STANFORD, L. DOWDY, M.J. LIEBMAN, T.A. KENT, *Impulsive and premeditated aggression: A factor analysis of self-reported acts*.
[36] For an example concerning schizophrenia cf. J.H. KRYSTAL, J.D. MURRAY, A.M CHEKROUD, P. R. CORLETT, G. YANG, X.J. WANG, A. ANTICEVIC, *Computational psychiatry and the challenge of schizophrenia*.
[37] Cf. I. FRADKIN, R.A. ADAMS, T. PARR, J.P. ROISER, J.D. HUPPERT, *Searching for an anchor in an unpredictable world: A computational model of obsessive compulsive disorder*.
[38] Cf. R.C. O'REILLY, M.J. FRANK, *Making working memory work: A computational model of learning in the prefrontal cortex and basal ganglia*.
[39] For the purposes of this paper, it is preferable to simplify the translation of *Erlebnisse* as "mental states", given the similarities of the use of this term in analytic philosophy and neuroscience.
[40] Cf. E. HUSSERL, *Formal and transcendental logic*, p. 159.
[41] Cf. A. ALES BELLO, *The sense of things: Toward a phenomenological realism*, p. 24.
[42] Cf. E. HUSSERL, *Ideas pertaining to a pure phenomenology and to a phenomenological philosophy, First book*, pp. 171-198.
[43] A focus on intentional processes and respective contents can be also identified in the first chapter of K. JASPERS, *General psychopathology*.
[44] Cf. E. HUSSERL, *Ideas pertaining to a pure phenomenology and to a phenomenological philosophy, First book*, pp. 79-81.
[45] Cf. J. PARNAS, J. NORDGAARD, S. VARGA, *The concept of psychosis: A clinical and theoretical analysis*.
[46] Cf. S. HAN, G. NORTHOFF, *Understanding the self: A cultural neuroscience approach*.
[47] Cf. E. HUSSERL, *Ideas pertaining to a pure phenomenology and to a phenomenological philosophy, First book*, pp. 326-344.
[48] Cf. E. HUSSERL, *Ideas pertaining to a pure phenomenology and to a phenomenological philosophy, Second book*, pp. 193-190.
[49] Cfr. D. PERROTTA, *L'esperienza emotiva tra causalità e motivazione.*
[50] Cf. L. BINSWANGER, *Melancholie und Manie*.
[51] Cf. E. HUSSERL, *Ideas pertaining to a pure phenomenology and to a phenomenological philosophy, First book*, pp. 18-19.
[52] Cf. J. PARNAS, L.A. SASS, D. ZAHAVI, *Rediscovering psychopathology*.
[53] Cf. D. MORAN, *Edmund Husserl: Founder of phenomenology*, pp. 171-173.
[54] Cf. A. MIYAKE, N. P. FRIEDMAN, M. J. EMERSON, A. H. WITZKI, A. HOWERTER, T. D. WAGER, *The unity and diversity of executive functions and their contributions to complex "Frontal Lobe" task*.
[55] Cf. E. HUSSERL, *The crisis of European sciences and transcendental phenomenology: An introduction to phenomenological philosophy*, pp. 151-152.
[56] Cf. L. BINSWANGER, *Melancholie und Manie*.
[57] Cf. R.C. O'REILLY, M.J. FRANK, *Making working memory work: A computational model of learning in the prefrontal cortex and basal ganglia*.
[58] Cf. C.R. HUSSAR, T. PASTERNAK, *Common rules guide comparisons of speed and direction of motion in the dorsolateral prefrontal cortex*.
[59] For examples and review cf. V. VALTON, L. ROMANIUK, J.D., STEELE, S. LAWRIE, P. SERIÈS, *Comprehensive review: computational modelling of schizophrenia*.
[60] In this case the example is better understandable in terms of "impulsive aggression", cf. E.S. BARRATT, M.S. STANFORD, L. DOWDY, M.J. LIEBMAN, T.A. KENT, *Impulsive and premeditated aggression*.
[61] In my opinion, Husserl would have spoken about "psychologism", cf. E. HUSSERL, *The crisis of European sciences and transcendental phenomenology: An introduction to phenomenological philosophy*, pp. 203-210.

References

Ales Bello, A. (2015). *The sense of things: Toward a phenomenological realism*, Springer, Berlin.

Ales Bello, A. (2017). *Consciousness and hyletics in humans, animals and machines*. In: G. Dodig-Crnkovic, R. Giovagnoli (eds.), *Representation and reality in humans, other living organisms and intelligent machines*, Springer, Berlin, pp. 247-260.

Barratt, E.S., Stanford, M.S., Dowdy, L., Liebman, M.J., Kent, T.A. (1999). *Impulsive and premeditated aggression: A factor analysis of self-reported acts.* In: «Psychiatry Research», vol. LXXXVI, n. 2, pp. 163-173.

Batterman, R.W., Rice, C.C. (2014). *Minimal Model Explanations*. In: «Philosophy of Science», vol. LXXXI, n. 3, pp. 349-376.

Bickel, W.K., Jarmolowicz, D.P., Mueller, E.T., Gatchalian, K.M., McClure, S.M. (2012). *Are executive function and impulsivity antipodes? A conceptual reconstruction with special reference to addiction*. In: «Psychopharmacology», vol. CCXXI, n. 3, pp. 361-387.

Binswanger, L. (1960). *Melancholie und Manie,* Neske Verlag, Pfullingen.

Binswanger, L. (1963). *Being-in-the-world: Selected papers of Ludwig Binswanger*, edited by J. Needleman, Basic Books, New York.

Borsboom, D., Cramer, A.O., Kalis, A. (2019). *Brain disorders? Not really: Why network structures block reductionism in psychopathology research*. In: «Behavioral and Brain Sciences», vol. XLII, pp. 1-63 doi: 10.1017/S0140525X17002266

Casali, M. (2017). *Generi psichiatrici come HCP: un nuovo approccio al dibattito discreto/continuo in psichiatria.* In: «Rivista internazionale di Filosofia e Psicologia», vol. VIII, n. 2, pp. 151-178.

Craver, C.F., Bechtel, W. (2007). *Top-down causation without top-down causes*. In: «Biology & Philosophy», vol. XXII, n. 4, pp. 547-563.

De Brigard, F. (2017). *Cognitive systems and the changing brain*. In: «Philosophical Explorations», vol. XX, n. 2, pp. 224-241.

Farah, M.J, Wolpe, P.R. (2004). *Monitoring and manipulating brain function: New neuroscience technologies and their ethical implications*. In: «The Hastings Center Report», vol. XXXIV, n. 3, pp. 35-45.

Fradkin, I., Adams, R.A., Parr, T., Roiser, J.P., Huppert, J.D. (2020). *Searching for an anchor in an unpredictable world: A computational model of obsessive compulsive disorder*. In: «Psychological Review», vol. CXXVII, n. 5, pp. 1-42.

Gallagher, S. (2018). *New mechanisms and the enactivist concept of constitution*. In: M. Guta (ed.), *The metaphysics of consciousness*, Routledge, London, pp. 207-220.

Han, S., Northoff, G. (2009). *Understanding the self: A cultural neuroscience approach.* In: «Progress in Brain Research», vol. CLXXVIII, pp. 203-212.

Hussar, C.R., Pasternak, T. (2013). *Common rules guide comparisons of speed and direction of motion in the dorsolateral prefrontal cortex*. In: «Journal of Neuroscience», vol. XXXIII, n. 3, pp. 972-986.

Husserl, E. (1969). *Formal and transcendental logic* (1929), translated by D. Cairns, M. Nijhoff, The Hague.

Husserl, E. (1970). *The crisis of European sciences and transcendental phenomenology: An introduction to phenomenological philosophy* (1936), translated by D. Carr**,** Northwestern University Press, Evanston.

Husserl, E. (1982). *Ideas pertaining to a pure phenomenology and to a phenomenological philosophy, First book: General introduction to a pure phenomenology* (1913). In: E. Husserl, *Collected Works*, vol. II, translated by F. Kersten, Kluwer, Dordrecht.

Husserl, E. (1989). *Ideas pertaining to a pure phenomenology and to a phenomenological philosophy, Second book: Studies in the phenomenology of constitution* (1912). In: E. Husserl, *Collected Works*, vol. III, translated by R. Rojcewicz, A. Schuwer, M. Nijhoff, The Hague.

Jaspers, K. (1997). *General psychopathology* (1959), vol. II, translated by J. Hoenig, M.W. Hamilton, John Hopkins University Press, Baltimore/London.

Kaplan, D.M., Craver, C.F. (2011). *The explanatory force of dynamical and mathematical models in neuroscience: A mechanistic perspective*. In: «Philosophy of Science», vol. LXXVIII, n. 4, pp. 601-627.

Krystal, J.H., Murray, J.D., Chekroud, A.M., Corlett, P.R., Yang, G., Wang, X.J., Anticevic, A. (2017). *Computational psychiatry and the challenge of schizophrenia*. In: «Schizophrenia Bulletin», vol. XLIII, n. 3, pp. 473-475.

Marraffa, M., Paternoster, (2013). *Functions, levels, and mechanisms: Explanation in cognitive science and its problems*. In: «Theory & Psychology», vol. XXXIII, n. 1, pp. 22-45.

Miller, E.K., Cohen, J.D. (2001). *An integrative theory of prefrontal cortex function*. In: «Annual Review of Neuroscience», vol. XXIV, pp. 167-202.

Miyake, A., Friedman, N.P., Emerson, M.J., Witzki, A.H., Howerter, A., Wager, T.D. (2000). *The unity and diversity of executive functions and their contributions to complex "Frontal Lobe" task: A latent variable analysis*. In: «Cognitive Psychology», vol. XLI, n. 1, pp. 49-100.

Montague, P.R., Dolan, R.J., Friston, P.J., Dayan, P. (2012). *Computational psychiatry*. In: «Trends in Cognitive Sciences», vol. XVI, n. 1, pp. 72-80.

Moran, D. (2005). *Edmund Husserl: Founder of Phenomenology*, Polity Press, Cambridge.

O'Reilly, R.C., Frank, M.J. (2006). *Making working memory work: A computational model of learning in the prefrontal cortex and basal ganglia*. In: «Neural Computation», vol. XVIII, n. 2, pp. 283-328.

Ouzir, M. (2013). *Impulsivity in schizophrenia: A comprehensive update*. In: «Aggression and Violent Behavior», vol. XVIII, n. 2, pp. 247-254.

Parnas, J., Nordgaard, J., Varga, S. (2010). *The concept of psychosis: A clinical and theoretical analysis*. In: «Clinical Neuropsychiatry», vol. VII, n. 2, pp. 32-37.

Parnas, J., Sass, L.A., Zahavi, D. (2013). *Rediscovering psychopathology: The epistemology and phenomenology of the psychiatric object*. In: «Schizophrenia Bulletin», vol. XXXIX, n. 2, pp. 270-277.

Perrotta, D. (2019). *L'esperienza emotiva tra causalità e motivazione: fenomenologia e neuroscienze sulla capacità di riflessione umana*. In: «Rivista internazionale di Filosfia e Psicologia», vol. X, n. 3, pp. 231-249.

Searle, J.R. (2004). *Mind: A brief introduction*, Oxford

University Press, Oxford.

SEO, D., PATRICK, C.J. (2008). *Role of serotonin and dopamine system interactions in the neurobiology of impulsive aggression and its comorbidity with other clinical disorders.* In: «Aggression and Violent Behaviour», vol. XIII, n. 5, 2008, pp. 383-395.

SINGH, I., ROSE, N. (2009). *Biomarkers in psychiatry*. In: «Nature», vol. CDLX, n. 7252, pp. 202-207.

SNYDER, H.R., MIYAKE, A., HANKIN, B.L. (2015). *Advancing understanding of executive function impairments and psychopathology: Bridging the gap between clinical and cognitive approaches*. In: «Frontiers in Psychology», vol. VI, Art.Nr. 328 – doi: 10.3389/ fpsyg.2015. 00328.

STUFFLEBEAM, R.S., BECHTEL, W. (1997). *PET: Exploring the myth and the method.* In: «Philosophy of Science», vol. LXIV, Supplement, pp. S95-S106.

VALTON, V., ROMANIUK,L., STEELE, J.D., LAWRIE, S., SERIÈS, P. (2017). *Comprehensive review: Computational modelling of schizophrenia*. In: «Neuroscience & Biobehavioral Reviews», vol. LXXXIII, pp. 631-646.

WANG, X.J., KRYSTAL, J.H. (2014). *Computational psychiatry*. In: «Neuron», vol. LXXXIV, n. 3, pp. 638-654.

WIDIGER, T.A. (2011). *Personality and psychopathology.* In: «World Psychiatry», vol. X, n. 2, pp. 103-106.

WIECKI, T.V., POLAND, J., FRANK, M.J. (2015). *Model-based cognitive neuroscience approaches to computational psychiatry: Clustering and classification*. In: «Clinical Psychological Science», vol. III, n. 3, pp. 378-399.