

MIND, BRAIN AND ALTERED STATES OF CONSCIOUSNESS

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ABSTRACT

The consciousness is the expression of an enormous and complex variety of neurobiological events, phenomenological and psychological that, from the early stages of development, prepare the emergence soil of the Self. It is a complex of tangible and intangible characters distinct from one another - neural infrastructure, awareness, temporality, qualitative subjectivity, intentionality - to such an extent as to seem welded faces of the same prism. Consciousness is not a simple function of the mind, but its organization. In this paper we intend to show how its order is not strictly hierarchical, but sustained by multiple horizontal levels, each of which in a structural and functional continuum with several emerging phenomena. The same distinction between quantitative aspects (surveillance) and qualitative (content of consciousness) of consciousness is founded on the premise that the supervision is regulated by widespread in projection systems of the brain stem, hypothalamus and thalamus; while the content of consciousness depends on the cortical activity, and particularly from the associative areas of the cortex connected between them. The so-called disturbances of consciousness (vegetative state, the minimally conscious state, a coma, the Locked in syndrome) suggests the existence of an alteration of a common underlying system. Although the current heterogeneity of the data makes it impossible to attribute with certainty whether positive or negative about the alleged absence of consciousness in the individual patient, the search is deriving significant benefits from the accumulation of neuroimaging evidence in paintings like coma, general anesthesia, sleep, epilepsy and somnambulism. In this sense, it seems increasingly urgent a deeper understanding of the neural correlates during sleep or general anesthesia, as well as the relationships between neural processes and altered states of consciousness generated by pharmacological manipulations.

Keywords: Consciousness, global workspace, time, memory, mid-brain, altered states.

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Theoretical Disputes

After a golden age in the second half of the 800 and the first half of '900 - profoundly influenced by the work of scholars such as Hughlings Jackson, William James, Charles Sherrington, Henry Ey, Wilder Penfield, Giuseppe Moruzzi,

John Eccles - the debate consciousness focused on the one hand, the identification of an explanatory model of the ways in which the psychological organization generates conscious awareness⁽¹⁾; secondly, on the understanding of the relationship between the neurobiological processes, cognitive and subjective quality of experience⁽²⁾.

Among the many perspectives, one of the most important is that those who - without giving anything to the arguments of the dualist, the skeptics or supporters of materialist ontology of 'mental' - believe in the irreducibility of subjective⁽³⁾. Our cognitive limitations, they claim, obstruct a clear understanding of consciousness and, if we find out the biological correlates of mental experiences, our subjectivity would remain unattainable. There is also the position of unifying cognition and corresponding functional states, placing experienced and cognitive behavior on the same level⁽⁴⁾.

According to the so-called functionalist mind it is a function of the brain and mental phenomena (pain, hunger, etc.). Should be considered only in terms of quantity and not quality. It is necessary, that is, to analyze the vertical modular structures that mediate the exchange of information between the organs sense-perceptual and the deputies central systems to the most complex computations⁽⁵⁾. These modules, each responsible for a specific domain, would be genetically determined and localized in specific brain regions⁽⁶⁾. In the more radical perspective, they do not exchange information - either with one another or with the central structures - but pursuing the predetermined and unchangeable action strategies. In the field of functionalist, the brain has been represented as a multitude of specialized microprocessors, distributed, and in competition with one another for access to a global workspace, where would be the coordination and control of the information. To determine the conscious subjectivity would, in short, a huge amount of information, below the threshold of awareness, which would see the thalamic-cortical circuit in play that would convert, through its ascending and descending projections, the distinct content of meaning expressions⁽⁷⁾.

In the late '90s, on the basis of evidence derived from experiments on the visual system of primates, it has established the idea that the origin of consciousness there is a system mediated by the thalamus-cortical oscillations similar to the activation of neurons some layers of the visual cortex. According Crick⁽⁸⁾, the consciousness would be formed according to the pattern of neural activity of the high visual areas, which project directly on the prefrontal areas creating a representative intermediate space between a lower floor of sensations and an upper plane of thought. This twofold dimension is also present in the hypothesis of neo-Darwinian Edelman⁽⁹⁾ of a 'primary consciousness' and a

'higher consciousness' which would allow the self to recall and tell their own experiences, freeing the subject from biological constraints of the 'here and now'. In this scheme, the primary consciousness would connect the axiological-categorial memory current perceptual organization, while the higher consciousness would operate a synthesis between the values memory and categorial memory areas distributed in the temporal, frontal and parietal⁽¹⁰⁾.

From competition-collaboration between these two types of neural organization - the non-Self that entertains sensory relationship with the world through the actual experience; and the Self acquires from social relations semantic and syntactic memory for concepts - emerge artistic creation, ethical systems and the scientific worldview. It must be said that consciousness was also represented as a strongly hierarchical structure⁽¹¹⁾.

In Damasio's vision, consciousness is indistinguishable from emotion: be born, in fact, as a special body feeling and consists of a 'proto-self' - based on biological issues such as fear, hunger, sex, anger and so on - that man shares with the higher animals. It will constitute, then, as 'nuclear consciousness', which gives the body the sense of self, 'here and now', without representations of the future. Finally, in a sort of ascending progression, it would become 'extended consciousness' which, through language, would give rise to the autobiographical self⁽¹²⁾.

In fact, structured and hierarchical models leave unresolved some explanatory gap. How could, in this scheme, these unfolding dynamic equilibrium between antagonistic organizations (visual, auditory, tactile, proprioceptive, and more) mutually influence on intra-sensory and inter-sensory plan to co-determine, ultimately, the contents of conscious awareness? Much more plausible seems to be a dynamic recruitment model, with characteristics of unity, diversity and variability that is integrated in a large neural space⁽¹³⁾. In such a case it is the job of a set of neurons connected to each other only a short distance (but with a certain degree of autonomy) to give rise to visual, semantic phenomena, motors and so on. Here, a critical role would be played by the frontal lobes and distributed by an aggregate of neurons of the thalamus-cortical system that operates at a speed of about one hundred milliseconds⁽¹⁴⁾. At the border between these structures and other brain areas would occur the phenomena of changing composition, variable and dynamic spatial distribution, which are decisive for

the cerebral integration: unified and differentiated integration, variable from moment to moment, in one and the same individual and from one individual to another⁽¹⁵⁾.

The time factor

Although consciousness originates in the cortical-subcortical space, only in the cortex it is accomplished the experience of time, that experience unmistakably individual and seamless, welding past experiences to future expectations⁽¹⁶⁾. And it's always the bark to unify the time of neural circuits with our conscious experience, which can be accessed through introspection and the reports in the 'first'⁽¹⁷⁾. Our meager notions about time revolve around the categories of succession and duration: the succession implies the distinction, eminently cognitive, including simultaneity and sequence of multiple events (although not in an absolute sense, because when they are at play time scales of tens of milliseconds the reliability of judgment fades); the term implies, however, the ability to grasp sequential perceptual events as if they were simultaneous, to perceive that the time interval without discontinuity⁽¹⁸⁾.

But how short it can be a time, that interval that is not a point but a constant flow from the present into the future and vice versa? According to James⁽¹⁹⁾, our time consciousness originates with different speeds, depending on the changes that we experience in a given time period: a minimum time necessary for the emergence of neural events related to a cognitive event⁽²⁰⁾. In fact, even today there is no agreement on the nature of brain processes that underlie our perception of succession and duration. The most likely hypothesis is that it should organize itself around the following orders of magnitude: under the age of 100 milliseconds is possible to distinguish the beginning and the end of an instantaneous event; after five seconds, the perception of time seems to be halved for memory⁽²¹⁾.

Other hypotheses indicate, at the basis of consciousness, a time unifying mechanism of neural activity that synchronize the pulses of about 40 Hz oscillations and medium unify reversibly part of the existing information into a coherent perception⁽²²⁾. If these assumptions were well founded, our consciousness would be determined not by the activation of a specific area of the brain, but concomitant activation of a series of neurons distributed in the brain, so that the neural discharges corresponding to

a same object give rise synchrony⁽²³⁾. Such fluctuations, however, represent a necessary condition, but not sufficient to produce a conscious experience. At least to some degree, in fact, the conscience requires explanatory levels of recurring access patterns much more complex.

Therefore, the phenomena general neural activity, detectable electroencephalogram, arise from activation, parallel inhibition and the synchronization of multiple neural circuits. It is a dynamic equilibrium, in which each event, the duration from 100 to 200 milliseconds, stabilized reflects the activation of a neural network in a distributed procedure and in parallel, which translates into a content of consciousness, as an abstract thought or a visual image⁽²⁴⁾. Under certain conditions, there are areas in which neural oscillations play a crucial role. In addition, certain states of consciousness (vigilance, falling asleep, waking, etc.) And diseases such as depression, epilepsy, Parkinson make record different thalamic-cortical rhythms, which have a term to changes in clinical populations^(25,26).

For example, in paranoid schizophrenics they are shorter, in manic patients show constant changes and so on^(27,28). These harmonies and neural in harmonies accompany the formation of form and content of thought, the appearance of emotions and, therefore, the emergence of self-consciousness. Here, it is inessential any metaphysical entity that presides over the appearance of consciousness. In this model, in fact, the ego is apparent neural organization and subjectivity from the physical brain, according to evolutions and variations which, as in a symphony, accompanied by the orchestra while not identify with⁽²⁹⁾.

The concept of temporality invites to reconsider certain seemingly obvious aspects of consciousness⁽³⁰⁾. First, the unity of conscious experience, which disappears as soon as you consider the events based on time scales of milliseconds; secondly, the immediacy, something too often attributed to consciousness. We have already seen how the visual information transmission is due to processes that require certain time intervals⁽³¹⁾. The time frames employed by these processes are irrelevant and no information can be accessed to consciousness until they are passed at least 500 milliseconds since his arrival to the cerebral cortex: evidence that led Libet to observe that the phenomena of consciousness are deferred with respect to the awareness action⁽³²⁾.

The experience of consciousness and extent of change

The term self-awareness designates the ability of consciousness to investigate itself, on its own decisions and actions. It is a reflective capacity that distinguishes categorically man's consciousness from that of animals and is linked to human language⁽³³⁾. In fact, both on phylogenetic floor than on the ontogenetic, thought and language are strongly associated, in a process in which the condition is thought of language possibilities. If the neurobiological consciousness can manifest itself in different ways, the contents of consciousness can only be communicated linguistically if it perceives, knowing to perceive; if you know that at any point, knowing of this 'where' geographical; if he knows to live 'here and now', turning this chronological now in 'lived time'⁽³⁴⁾. The weakening or loss of this possibility is the hallmark of patients with cerebral dementia.

The thought phenomenological showed how self-consciousness, in its intent, is explicit historically, value-free and verbally^(35,36). The concept of field of consciousness helps to identify the dynamics of her consolidation as proto-experience, as the opening of the subject in the world through an orientation and a meaning that mark this intentional relation. The field of consciousness is, therefore, the presence, the possibility of living in a time period that is experienced and does not measure the change, which is embodied temporality and not an arithmetic meter⁽³⁷⁾. At full speed and at a normal level of consciousness monitoring becomes constituent capacity and ordering, in an ever-changing perspectives, which requires an optional structure and availability of the subject. Here, even the supervisory concept is transformed into that attitude typically human to stand in front of oneself, in perfect awareness of the situation, as well as in the critical perception of their disease⁽³⁸⁾. Thus the structure of consciousness can access organizational autonomy to become the lived body⁽³⁹⁾.

This mode is divided conscious of Is in the field of consciousness, but goes beyond it to become I in its historicity. I do not have a viewer to an imaginary philosophical theater, but the ego actor of the various constituent degrees of consciousness, which ascends to its highest order: meta openness to the world^(40,41), a new categorical horizon, consisting of values and hierarchies of values, norms and decisions, as freedom and necessity⁽⁴²⁾.

Altered states of consciousness: between dimensional and categorical

There is growing agreement among scholars that consciousness originates from a proto-experience that integrates dynamic cortical and subcortical in a time structure. In this original point, intentionality is welded to real world objects through continuous changes in perspective⁽⁴²⁾. They would not even be conceivable, if not in these conditions, those states of attentional and perceptual clarity, between the ends of sleep and of hypervigilance, which enable man to debate with himself, in full awareness of their normal and pathological. As the subjective experience of a system in action, awareness poses serious problems to the experimental investigation, unlike watch that instead can be investigated experimentally with a good degree of approximation⁽⁴³⁾. It must be said that ordinary difficulties encountered in discussing of consciousness become extraordinary in the field of consciousness disorders. Everything here seems more confused and undetermined.

Around the middle of the twentieth century, the French psychiatrist Henry Ey⁽⁴⁴⁾, through a refined blend of the concepts of organization, intentionality and perceptual field, described the field of consciousness as the horizon within which the explicit experience its meaning and his momentary amplitude, transient, synchronic^(45,46). Rethink the conceptual value today would help us to better understand not only the genealogy, the background and the layers of consciousness, but also the evolutionary order of our social life. In disorders of consciousness - where the neurophysiology is intertwined to the clinic in a permanent confrontation between the descriptions in the 'first' and the observation in the 'third person' - categories such as openness, the extension and the suspension of time become essential aspects^(47,48). It is always useful to distinguish disorders of consciousness in the presence of qualitative changes in the field of consciousness. In fact, consciousness is not synonymous with the field of consciousness^(49,50). It's not even a current ordered and bounded processes. As the flow of processes in the open, consciousness goes beyond the proper scope. Just the unity between subjectivity and world shows how the traditional distinction between quantitative and categorical levels (attention, alertness, sleep, coma) and qualitative-dimensional (subjective experiences such as feelings, thoughts, emotions) should be sup-

plemented with the analysis of hierarchies and the different types and degrees of consciousness, both synchronic (the field of consciousness) that diachronic (the ego or personality). Every aspect of our social life, moreover, depends on the way in which consciousness integrates and transforms data environment⁽⁵¹⁾. However, well beyond his own capacity for transformation, consciousness can be strongly modified beyond our control, such as when we focus in meditation or contemplation we collect⁽⁵²⁾. Only a clear lucid perception of our presence - that is, to be ourselves to think, you know, to want, to do - guarantees a conscious psychic life: just what is lacking in those states characterized by feelings of unreality and the familiar loss themselves and the world that submerges the boundaries of the self making them indistinct and indeterminate.

Discontinuity of consciousness

The consciousness disorders are traditionally divided into quantitative and qualitative^(53,54). Among the quantitative disorders include those conditions that affect attention, alertness and other spheres objectivizable: confusional states, the dullness, lethargy, coma and some clinical pictures on an organic basis⁽⁵⁵⁾. Among the qualitative disorders include, however, those conditions that affect the contents of consciousness, the experience of self and the world around: depersonalization, derealization, dissociative phenomena of psychogenic basis, dreamlike states and oneiric, confusion and twilight⁽⁵⁶⁾.

In fact, this is an artificial distinction. Not infrequently, in fact, the qualitative disorders are quite contiguous to those amounts, and this makes it difficult for a clear demarcation⁽⁵⁷⁾. Of course this is not the place to groped a meticulous (as complex) definition of consciousness disorders. However, for the extreme importance that these have in general discourse on the conscience, give the general classification. You can identify at least four levels of consciousness quantitative disorders:

- the first level includes, among others, clinical expressions such as numbness, states of decreased consciousness, hypnoidal changes and more. Under these conditions, the patient still distinguishes itself from the outside world, fantasy from reality, recognizes people and are usually asleep⁽⁵⁸⁾. It is the first stage towards the torpor: a sort of pre-coma. They can be determined by organ-

ic causes (brain trauma, severe metabolic abnormalities, tumors) or taking alcohol and drugs;

- the second level belong, among others, the dream and oneiric alterations, which involve quantitative and qualitative abnormalities associative, an examination deformation of reality, the presence of delusions and hallucinations cues^(59,60). The distinction between reality and fantasy is still partially present. They recur in confusional syndromes of organic base (delirium), in the acute phases of schizophrenia and mania;

- the third level belongs to a narrowing of the field of consciousness. The onset is sudden, the symptom pattern is limited in time and, generally, there is recovered fully. The patient seems completely self-absorbed. It manifests a progressive inability to integrate the temporal and spatial experiences. There is no inconsistency or dulling, but fear, dysphoria, were mystical-ecstatic. The patient has little memory of what happened. The activity of the consciousness only to a narrow range of perceptions, representations, feelings⁽⁶¹⁾. The narrowing of the field of consciousness is psychogenic origin and occurs in syndromes such as those from somatic conversion, post-traumatic stress, prolonged imprisonment (Ganser syndrome). These quantitative disorders can also be caused by seizures, head injuries, drug abuse.

- the fourth level includes, among others, a confused state where it is absent consideration of the fact, there is linguistic incoherence, disorientation temporal-spatial, disorganized thinking and speech, perception disorders (illusions, hallucinations), disorders of the sleep-wake rhythm⁽⁶²⁾. It occurs in pathological conditions such as delirium or acute and chronic organic confusion syndromes, trauma, metabolic disorders in paintings, in tumors and toxic states⁽⁶³⁾. Qualitative disorders of consciousness include the phenomena of derealization and depersonalization, identity disorder dissociative (a defined multiple personality time), psychogenic amnesia, from somatic conversion syndrome, somatoform disorders, post-traumatic stress syndrome, acute psychosis and more. They can arise for medical causes (mostly secondary to brain damage) or psychological causes such as expression of a defense that intervenes in extreme situations (trauma) and subconscious conflicts that make embankment anguish otherwise organisable.

Historically, the study of psychopathological conscious awareness is of utmost importance. The formal features identified by Jaspers⁽⁶⁴⁾ remains a key:

- the direction of activities. The social life is governed by the original activity, irreducible to anything else. The ego is aware of thinking, acting and so on. This sense of its presence is missing in the states of depersonalization, in which prevail a radical perceptual estrangement, an automatism of the will, a feeling of lack of their own feelings;

- awareness of their uniqueness. I am one at any given time. That the ego stability is undoubted, even in its extreme variability, it is demonstrated by the study of the dissociations of the personality;

- identity consciousness. I am one of yesterday in the passing of time;

- Self-consciousness as opposed to the outside world and to others.

This aspect fully highlights the unique originality of social life. The harmonious unfolding of these features - which according to Jaspers are the basis of knowledge - is greatly impaired when taken drugs and psychedelic (cannabinoid psilocybin, mescaline from lysergic acid up to the most recent) and are such phenomena as the spread of thought (the patient has the impression that thoughts will project in the environment), in the fearful onset schizophrenic shift feeling, the sensation of being at the mercy of dark forces, the hypnotic state, and more^(65,66). Whether quantitative or qualitative disorders, the psychopathological study must always be accompanied by an analysis of the evolution and dissolution of the relationship between cortical and subcortical structures. For example, lesions of Ascending Reticular Activating System, as well as a dysfunction of both hemispheres of the brain, can cause quantitative alterations of consciousness⁽⁶⁷⁾. In contrast, cortical lesions, in the absence of a bilateral dysfunction, determine changes in consciousness content congruent with their functional specialization.

In a study a few years ago^(68,69) were compared to the major pathophysiological been linked to the lack of consciousness (deep sleep, coma / vegetative state, general anesthesia, loss of consciousness during a seizure). It has been highlighted, in particular, as these paintings, even if caused by a different etiopathogenesis, share a series of objective able elements: regular electroencephalographic activity, a significant decrease in metabolism in the frontal-parietal regions, a generalized block of the functional connections both cortical-cortical that thalamic-cortical, a state of 'non-compliance'. These structuring effects help to better understand some aspects of the temporal structure of con-

sciousness and related neural processes⁽⁷⁰⁾. There are, for example, patients can sleep well, be careful, pleasant conversation, in the absence of apparent disorder of consciousness or altered tuning. Yet, these are patients who often do not know much of what they should know: the place where they are and they come from. It happens often they make mistakes, easily lost, to ignore the time, date, your age. Even in full wakefulness they are unable (or only partially) to evoke the lost information.

Although the scientific community debate about these issues (which is most sensitive) is proceeding rapidly, in ordinary clinical practice are still the supervisory concepts and knowledge to define the state of consciousness changes. For example, the non-voluntary closure of the patient's eyes peremptorily corresponds to a closing of consciousness in the world^(71,72). If in coma has vanished awareness and, in more severe cases, the vital functions (such as respiratory) must be assisted mechanically, in a vegetative state, often in correspondence of the sleep-wake cycles, the patient alternates closure and eye opening^(73,74). Compared to coma, in a vegetative state can be a motor activity and facial expressions no purposive⁽⁷⁵⁾. Although there are many factors to consider, patients, before passing to the vegetative state, usually spend a few weeks in which the risk of no return becomes absolutely and painfully probable⁽⁷⁶⁾ coma, passed. Besides the vegetative states, there are also minimally conscious states⁽⁷⁷⁾. Here the terminology and clinical picture becomes even more confusing. The diagnostic criteria for this syndrome-container, characterized by severe alterations of consciousness, are different from those of the vegetative state⁽⁷⁸⁾. The presence of awareness is minimal and intermittent. Patients appear to interact spontaneously or in response to specific stimuli, almost reasonable, though transitional, with the surrounding world. It is, however, of actions that exclude the execution of complex tasks and protracted in time. The elements that are common to these two clinical pictures are remarkable, and for this reason have been inscribed in a clinical spectrum as defined neurological state of low level, which allows to set aside outdated concepts as Apallic, coma vigil, and more.

Future directions of research

Despite the enormous efforts made, there is not yet agreement on the biological nature of consciousness and its relationship with the awareness.

All this is reflected dramatically in the classification systems⁽⁷⁹⁾. It is explanatory gap that hinder the birth of a science of consciousness and make it more difficult on a clinical level the identification of shared interpretive criteria in anesthetic practice, in the classification of altered states of consciousness and conscience of the minimum conditions⁽⁸⁰⁾. Research into altered states of consciousness would benefit greatly from the acquisition of data and paradigms verified through neuroimaging methods in different conditions such as coma, general anesthesia, sleep, epilepsy and somnambulism. In this sense, it seems increasingly urgent a deeper understanding of the neural correlates during sleep or general anesthesia, as well as the relationships between neural processes and altered states of consciousness evoked by pharmacological manipulations⁽⁸¹⁾.

Probably new developments allowed by the implementation of brain-computer interface technology will enable some of these patients, particularly those “locked-in” to express their thoughts, feelings, desires and more⁽⁸²⁾. The deployment of hardware, software and the statistical analysis of the signals and modeling of brain EEG recordings from or spectroscopy devices will be needed to obtain trials with an acceptable precision and reproducible at the individual subject level. On the other hand, without a gold standard for conscious awareness⁽⁸³⁻⁹⁶⁾ it is particularly difficult to avoid both false negatives (ie when you do not detect signs of consciousness or communication in people aware) and false positive results (ie, the detection of consciousness or communication when it is absent). The challenge is still to identify the biological correlates of functional recovery of consciousness after cranial or anoxic trauma. From here may arise for clarification of the mechanisms that make it even obscure consciousness and its disorders.

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