Consciousness and co-consciousness, binding problem and schizophrenia

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Summary
At this time it is thought that binding of synchronized and distributed activity is crucial for the mechanism of consciousness. There are suggestive findings that disturbances in this feature binding produce disintegration of consciousness in schizophrenia. It leads to disturbances in reflection of the self and dissociated psychic fragments may be experienced as parts of the external world. Disturbances in the feature binding that lead to disintegration in neural communication among some parts of the brain thus seem to be a neurophysiological counterpart of psychological dissociative processes related to stress response and cognitive, affective and neuroendocrine dysregulation.

BINDING PROBLEM AND CONSCIOUSNESS

Because of changing stimuli or internally generated activity the brain continuously changes activity patterns of functionally synchronized and integrated groups of neurons. Mechanism that enables functional binding of neurons is not known, but it is supposed that this mechanism is functionally connected to mechanisms of consciousness.

Crick and Koch (1992) in the paper concerning the visual consciousness deal with the problem that a seen object is in the brain represented by groups of synchronized excited neurons located in different parts of the brain. There is growing evidence about these synchronized processes and in any study was not found a special place in which distributed information comes together. This hypothetical place was dubbed Cartesian theatre. Different attributes of visual information are processed in many different parts of the brain but likely without full neuroanatomical convergency, from the classical point of view, necessary for synthesis of processed information (Crick and Koch, 1992; Singer, 1993, 2001; John, 2002). This distributed neocortical processing is according to modern evidence necessary also for other sensory and motor functions (Singer, 1993, 2001).

A solution of the binding problem is an important topic of many approaches to the problem of consciousness. A common traditional view of many scientists is that consciousness emerges from a dynamical nucleus due to persisting reverberation and interactions of neural groups (Singer, 2001; John, 2002). An example is approach by Libet, who thought that subjective experience represents field emerging from neural synchronization and coherence (John, 2002). Physical explanation proposed Freeman, who suggested that images of the world in the human mind emerge due to creating order from non-linear chaotic activity of large groups of neurons (Freeman, 1991; John, 2002). Similarly, also other studies connect consciousness to complexity.
and entropy in the central nervous system (Tononi and Edelman, 2000; Sporns et al. 2000, 2002; John, 2002; Seth et al., 2006). There are also approaches that tend to explain the feature binding as a process with zero-lag correlation (“instant action at distance”) without material physical field mediating the interaction. This approach to understand consciousness is based on processes in the brain structures that in principle could be explained using the quantum theory and its concept of the quantum wholeness that means physical process of time independent entanglement between initially interacting and spatially distributed subsystems called quantum nonlocality (Marsh, 1989; Penrose, 2001; John, 2002).

The binding problem presents unresolved problem of neuroscience, which strongly suggest that consciousness represents unity of different parts of the brain and different aspects of locally processed information. In this context, psychopathological processes that cause dysregulation and disturbances in the unity of conscious experience could be closely linked to disturbances of neural binding and coherence in the brain. Historically, consciousness and disturbances of its unity are related to the term dissociation that means disintegration and disassociation of mental contents that constitute memory, consciousness and identity.

**DISSOCIATION AND CO-CONSCIOUSNESS**

The term dissociation has its origin in the work of Pierre Janet (Janet, 1890; van der Hart, Friedman, 1989) but even before him, in the year 1845, Moreau de Tours used the term psychological dissolution (désagrégation psychologique) (Ellenberger, 1970; Hilgard, 1974). Analogically Hughlings Jackson (Ellenberger, 1970; Meares, 1999) used the term “dissolution” and also the term "dreamy state" that mean splitting consciousness leading to many symptoms, such as depersonalization, derealization, hallucinations and other. Morton Prince, one from Janet's contemporaries, for the first time used the term "co-conscious" in the sense that two consciousness may be isolated from one another (Ellenberger, 1970; Hilgard, 1974). Max Desoir identified two main streams of mental activity as upper or lower consciousness, where the lower one may emerge – for example, in hypnosis (Ellenberger, 1970; Hilgard, 1974). F. Myers introduced the term subliminal Self that was later used also by William James (Ellenberger, 1970; Hilgard, 1974).

Janet initially elaborated the concept of dissociation in his work 'Psychological automatism' (Janet, 1890; Ellenberger, 1970; Havens, 1966; van der Hart and Friedman, 1989), where he sketches his notion of psychic functions and structures. He dealt with psychological phenomena often observable in hysteria, hypnosis, states of suggestion or possession. From 1889 his work was greatly influenced by his collaboration with J.M. Charcot in the Parisian hospital Salpetrière.

Janet considered many of the psychopathological symptoms as a defect of the psychic wholeness. He described many forms of abnormal states of consciousness with their own memory that are inaccessible for the normal state of consciousness. These dissociated elements called fixed ideas that may produce many psychopathological symptoms. Janet and French school in Salpetrière became the source for the following development of psychoanalysis and other trends in depth psychology.

Similarly as disorder of integrity (‘splitting’) was defined also schizophrenia by classic Swiss psychiatrist Eugen Bleuler (Ellenberger, 1970; Scharfetter, 1998; Bottero, 2001). It corresponds to some modern findings (Tononi and Edelman, 2000) and also to them that examine dissociation in schizophrenic patients (Bernstein and Putnam, 1986; Spitzer et al., 1997; Startup, 1999; Read et al., 2001).

New interest in the theory of dissociation appeared after the Second World War along with a restoration of interest in the study of hypnosis in the work of Ernest R. Hilgard that continued in Janet's tradition. His neodissociation theory is sketched in the work 'Toward a Neodissociation Theory: Multiple Cognitive Controls in Human Functioning' (Hilgard, 1974) and is described in detail in his book (Hilgard, 1986). According to Hilgard, the secondary dissociated consciousness is characterized by the hidden observer that has the quality of a central stream of consciousness, in which information converges from many secondary streams or secondary personalities.

According to modern definition dissociation is understood as a special form of consciousness in which events that would ordinarily be connected are divided from one another (Li and Spiegel, 1992). It may be also less generally understood as inability to integrate some (co-conscious) psychic contents into the (dominated) consciousness (Bernstein and Putnam, 1986). Dissociation typically affects memory systems that may lead to memory loss restricted to a circumscribed period of time or category of events within the individual's life that causes exclusion of the experience from consciousness and the inaccessibility of voluntary recall of mental events associated with the trauma (Nemiah, 1991; Bob et al., 2005, 2006; Bob, 2007). Typical physiological reactions to traumatic stress and dissociation are disturbances of self-regulatory systems such as HPA axis resulting in hyperarousal, tachycardia or other symptoms of autonomic nervous system instability (Newport and Nemeroff, 2000; Teicher et al., 2003; Read et al., 2001). HPA axis is functionally closely related to neuroendocrinological balance, control hormonal levels, energetic metabolism, neuroimmunomodulation and disturbances of memory during stress reaction (Newport and Nemeroff, 2000; Mason et al., 2001; Payne et al., 2006; Plotsky et al., 1998; Teicher et al., 2003; Gavrilovic and Dronjak, 2005; Nakayama et al. 2005; Takahashi et al. 2005; Umegaki et al., 2006). According to neurodevelopmental research are most serious disturbances of HPA axis caused by traumatic events such as childhood abuse or neglect in
thinking produce many symptoms of schizophrenia in the visual or auditory system. Self-generated eye movements generate a “corollary discharge,” or “efference copy” of the motor plan, informing the visual cortex that the changing of a visual input results from a self-generated action. A similar mechanism may exist in the auditory system, where corollary discharges from motor speech commands prepare the auditory cortex for self-generated speech, perhaps through a link between frontal lobes, where speech is generated, and temporal lobes, where it is heard (Ford et al., 2001a,b, 2007; Poulet and Hedwig, 2007). These findings provide direct neurophysiological evidence for a corollary discharge that transforms sensory responses to self-generated and relative to externally presented percepts. These percepts fail in patients with schizophrenia in comparison to healthy subjects. For example, inner speech is misidentified as external voices (Ford et al., 2001a,b, 2007; Poulet and Hedwig, 2007).

Loss of distinctions between internally generated psychic activity and external input is crucial for dissociative states as were formulated by Janet and also for the dreamy states defined by Hughlings Jackson (Meares, 1999). Dissociation represents disturbances of self-identity when own psychic contents are splitted and disintegrated from consciousness by dissociative mechanism, and create the co-conscious (or unconscious) level of psychic functioning.

CONCLUSION

Co-consciousness represents recent evidence of psychopathology and is likely related to disorder of integrity at the level brain processes regarding the feature binding. In this context the binding problem seems to be a very difficult and key problem for understanding of brain functions and consciousness. Its key role may be important not only for understanding of the normal functions of consciousness but also for abnormal functioning in psychopathological states. Recent findings suggest that disturbances of binding correspond to functional disconnection among some parts of the brain as was hypothesized already in 19th century by Hughlings Jackson and called psychological dissolution (Ellenberger, 1970; Meares, 1999). Similar term called dissociation introduced by Janet seems to be a very important for understanding psychopathological processes (Ellenberger, 1970; Meares, 1999). In this context, research following Bleuler's and Janet's tradition confirms significant influences of stress-related events and dissociation in pathogenesis of schizophrenia (Bernstein and Putnam, 1986; Spitzer et al., 1997; Startup, 1999; Read et al., 2001; Bob et al., 2006). Also several research findings in the study of brain complexity and neural synchronization support the hypothesis that specific functional fragmentation of neural subsystems could be linked to dissociation and splitting in schizophrenia (Bob et al., 2007). Taken together, these findings suggest that further research
could more comprehensively explain the relationship between psychological disintegration and neural processes and may help to find specific neurophysiological and neuroendocrinological alterations linked to disturbances in brain integrity and binding.

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