Dissociation in Brain and Mind as a Consequence of Competitive Interactions

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Abstract: We show some connections between psychodynamic view of the psychic system, in which dissociation is a basic element of the system dynamics, and neural level of the brain. The dissociation represents competition among complexes that correspond to ideas or mental representations in parallel distributed processing (PDP). In PDP models dissociation represents low synaptic strength among mental representations and neural assemblies as their neural correlate. When this associated strength in activated ranges of the neural network is low, it leads to strong competition among the cell assemblies, which represent these mental representations. As a consequence of a strong competition among mental representations deterministic chaos is present. It leads to often instantaneous reduction of excitatory thresholds of many neural populations not excited in that particular combination before. Its EEG correlate is hypersynchronized activity- a burst. We show some examples in which experimental manifestations of psychic competition (dissociation) are correlated by burst EEG activity. It corresponds to theoretical connections and supports this hypothesis that dissociation in the psychodynamic sense may be grasped as competitive relationship of mental representations and their neural correlates (neural assemblies).

Competition is a basic term of contemporary biology. At first it emerges in Darwinian biology and represents selection as a competition among many forms and sorts of living organisms. Similar competitive interactions are probably present in the brain as competitive interactions among neural assemblies which represent mental representations. It corresponds to the description of psychological competition among mental representations or ideas or according to psychodynamic level of description it represents competition among psychic complexes. This competition in psychodynamic point of view is called dissociation and for example it represents intrapsychic conflict.

The term dissociation has its origin in the term dis-association which means disconnecting or lowering the strength of associative connections. Already before Janet, in the year 1845, Moreau de Tours used the term psychological dissolution (désagrégation psychologique) [1]. Analogically Hughlings Jackson [2] used the term "dissolution" and also the term "dreamy state" which meant splitting consciousness leading to amnesia and other symptoms, such as depersonalization, derealisation, hallucination or disagregation of perception. Morton Prince one from Janet's contemporaries used the term "co-conscious" in the sense that two consciousnesses are isolated from each other [3]. Max Desoir identified two main streams of mental activity as upper or lower consciousness where the lower one may emerge for example in hypnosis [3]. F. Myers introduced the term subliminal Self which was latter supported also by Wiliam James [3].

Janet firstly elaborated the conception of dissociation in his work Psychological automatism [4, 5, 1] where he sketches his notion of psychic functions and

structures. He deals with psychological phenomena often observable in hysteria, hypnosis, in states of suggestion or possession. From the year 1889 his work was greatly influenced by the collaboration with J. M. Charcot in the Parisian hospital Salpetrière.

During complete psychological automatism [4, 6] consciousness is totally dominated by repeating past experiences for example in somnambulism or hysterical crises. In a case of partial automatism only a part of consciousness is dominated for example during hypnotic anaesthesia when for example touching of some object is not registered by consciousness but may be registered by secondary consciousness called by Hilgard about one hundred years later as hidden observer [7]. In cases of complete or partial automatism systems of unconscious fixed ideas which repress conscious control and perception play an important role. They may emerge by many forms of symptoms, for example also by paroxysm which may be grasped as representation of psychological trauma when a fixed idea is transformed into hallucinations and body movements [1]. Janet considered hysteria as a defect of the psychic wholeness. Similarly in cases of abulia he thought about degeneration of will as a consequence of influence of unconscious processes which lead to repression of conscious psychic activity. Janet described many forms of somnambulism which represent abnormal states of consciousness with their own memory that are inaccessible for the normal state of consciousness. Fixed ideas are presented in the form of dreams, dissociative episodes, for example hysterical attacks or during hypnosis as secondary consciousness. A characteristic feature of these states is lowering of mental level (abaissement du niveau mental) which is manifested by increasing dissociation, mental depression connected with reduction of psychological tension and leads to integration in lower psychological level corresponding to the level of the dominant fixed idea and its psychological automatism.

Some new interest in the theory of dissociation appears after Second World War with the restoration of the interest in the study of hypnosis. Then great interest in psychoanalysis follows and leads to forgetting its origin in French school in Salpetrière where S. Freud studied in years 1885–86 at J. M. Charcot [8]. According to Freud dissociated states are elicited by the repression of the libido energy which is of sexual nature. Other authors representing the depth psychological trends explained libido differently than Freud. According to C. G. Jung the libido represents general psychic energy, for Alfred Adler it represents will to power and Viktor Frankl considered the libido as meaning of life.

In Janet's tradition continued Ernest R. Hilgard. His neodissociation theory is sketched in the work "Toward a Neodissociation Theory: Multiple Cognitive Controls in Human Functioning" [3] and is described in details [7]. According to Hilgard, the secondary dissociated consciousness is characterized by the hidden observer which has the quality of the central stream of consciousness in which converges information from many secondary streams or secondary personalities.

According to many findings dissociative processes thus must be seen as clinical reality [9].

The first successful model of neural network suitable for the study of dissociative processes was suggested by Bower [10, 11]. In this model memory is saved in single elements of network. The memory content may be excited, when its corresponding memory element is activated at the threshold level. There are elements with excitation influence on memory contents and also elements which inhibit them. Bower assumes that dissociative disorders can be consequences of state dependent learning. Very similar is the model of traumatic dissociation [12]. Other class of models is represented by neural networks in which memory is parallelly distributed in the space of the network [13]. This network is able to explain wider class of dissociated processes, for example the course of posthypnotic amnesia. Parallel distributed processing is a model for microstructure of cognition [14] where activities of many neurons are described as configurations or neural patterns and their psychological correlates are called mental representations. The neural network state is described by superposition of neuronal patterns. Neural patterns (configurations) in the superposition are in "prespace" which corresponds to psychic space and active neural patterns are selected from this superposition.

Dissociation represents inability to integrate some psychic contents for example from memory into the consciousness and dissociative states thus represent mental representations, which are inaccessible to consciousness. This inaccessibility may be explained in the sense that among the certain states is antagonistic competitive relationship. These states can be modelled by parallel distributed processing [11, 14, 15]. Many activity configurations in parallel distributed processing network are represented as points in an N-dimensional plane, where N represents number of neurons in the network. In a simple case we have two neurons and all their possible activities, which are given by synaptic strength and can be represented by two axes. The third axis represents the probability of given configuration. This produces three-dimensional plan (landscape) and "peaks" in this plane represent favoured activity states. Isolated peaks in this plane represent dissociated states [15]. All configurations in the N-dimensional plane represent dynamic system, which is changed during the time with each new input. This PDP model is used for modelling of some pathological states as for example functional amnesia, multiple personality disorder and post-traumatic stress disorder.

In understanding dissociation on the neurophysiological level we must consider some aspects of the brain complexity. Generally complexity of the system means in a simple definition its composition from simple units or its dimensionality, which tends to evolving during the time [16]. Structures, which have higher number of dimensions are generally viewed as more complex. In the case of neural networks or electroencephalogram this means that there is a competition among oscillating neuronal cell assemblies (neural configurations). Complexity is for example higher

during divergent (creative) thinking than during convergent thinking (analytical thought) [17], which lead to suppressing competition among neural assemblies. Also people with higher intelligence have higher EEG complexity [18]. Competition among cell assemblies may be defined as the number of simultaneously active neuronal assemblies, which are involved in performing the task. For example during convergent analytical thought there are reduced all information irrelevant for solving the problem and at the same time is reduced number of competitive neural assemblies and also the complexity is lower. Higher competition during creative thinking leads to establishing new associations among neural representations of mental states [17]. Competition among cortical neural cell assemblies which excite one another and which are unable to agree on a common frequency of oscillations thus probably represents dissociated mental states. When associated strength in these newly activated ranges of the neural network is low, it leads to strong competition among the cell assemblies, which represent these mental representations. In the parallel distributed processing, these dissociated states with low associated strength are represented by isolated "peaks" [11, 14, 15]. For example the dissociation in schizophrenia as the loosened organization of thought has been found to be associated with a pronounced increase in dimensional EEG complexity at frontal recording sites [17].

In some cases of competition among neural assemblies may be present chaotic states which probably represent important aspect of brain dynamics. In the past the term chaos meant absence of order and unpredictability. Now the term chaos connotes the idea of underlying structure and the potential for describing a complex system with the aid of relatively simple mathematical formulations and its definition is based on nonlinear mathematics. Generally chaos represents low-dimensional aperiodic signal and is used for describing the behavior resulting from very many degrees of freedom in the systems with very high complexity [19]. In the brain chaos probably arises from the competition of two or more parts of the brain (neuronal assemblies) [20] and on the psychological level their mental representations. It leads to often instantaneous reduction of excitatory thresholds of many neural populations not excited in that particular combination before. It represents process called as bifurcation. Bifurcations characterize networks that are sensitive to very weak initial conditions. On the psychological level they are represented for example as unexpected original ideas or in pathological cases as epileptic paroxysms [19, 20]. A characteristic feature of neural activity as a consequence of the brain chaos is synchronous collective activity- a burst [20]. The burst waves have often the frequency about 40 Hz and high amplitudes. In [20] author speculates that chaos underlies the ability of the brain to respond flexibly to the outside world and to generate novel activity patterns, including those that are experienced as fresh ideas. Chaos thus expresses underlying unpredictable order of attractors and enables complex behavior of the brain [20, 21].

Dissociative states theoretically grasped as consequences of the competition among mental representations have, according connections mentioned above, as their EEG correlate hypersynchronized- burst- activity. It is interesting that this supposed correlation which is deduced from the model mentioned above correspond to some experimental findings. From psychological point of view the competition among mental representations represents the competition among psychic complexes as a manifestation of dissociation. As an example we may introduce the burst waves arising as reaction to very painful or to rather delicate questions [22]. In these questions repressed complexes are evoked and burst waves are consequences of hypersynchronization. Dissociation may be evoked also by emotional activation or by influence of drugs. Heath found hypersynchronized EEG activity during extremely affected states, for example during orgasm, smoking of marihuana, emotional dysphoria or during psychiatric interview about problematical chapters from the patients life when unconscious traumas or complexes were evoked [6, 23]. Monroe reported [24, 25] that burst which is present as subcortical ictus correlates at times with a creative or an inspirational thought or act or on other occasions with a single impulsive act motivated by disphoric affects, whereas a more prolonged ictus leads to precipitous changes in behaviour which can simulate almost any form of psychopathology, particularly the

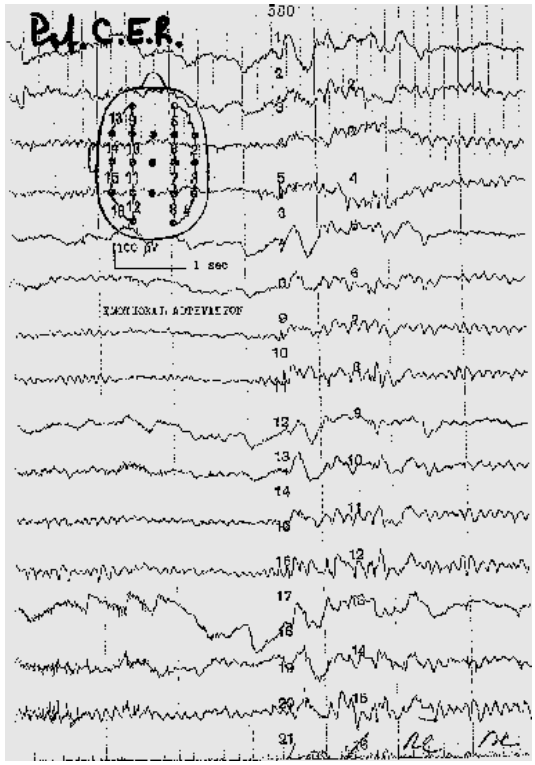

Figure 1 – Patient C.E.R. with grand mal epilepsy and post-traumatic psychosis. Some states of anxiety are provoked by agitation, others by sleep deprivation. The curve shows fairly normal EEG activities also during hyperventilation. Atypical, but major generalized epileptic discharges appear repeatedly in ten second in response to psychotraumatizing inquiries about embarrassing family problems.

atypical affective and schizophrenic disorders. Monroe also reported (Monroe, 1982) : "... that there are numerous areas within the subcortical emotional circuits that, when discharging, are correlated with intense disphoric (aversive) affects as well as impulsive behavior." Inspirational thought represent new ideas or creativity and in certain persons it correlates with epileptic discharges (burst) as for example in Vincent van Gogh [25] or F. M. Dostoyevsky. These experimental data are introduced as examples and there are also other findings which support this view of dissociative processes and their EEG correlates [26, 27, 28].

At the end we will present a short case study for illustration the relationship between the ictal hypersynchronized activity and dissociation on the psychic level. The patient C.E.R. with epilepsy had also various psychiatric diagnoses as anxiosity, depression and agoraphobia with psychotic features. Her epilepsy was probably connected with a past traumatic event (automobile accident). First her epileptic seizure became about three years after the event. An important previous trauma in her life was due to an attempt of violation by an adult man in her 13 years. She had unsatisfactory sexual relationship with her husband and negative relation to masturbation (she "never masturbated"). Before and at the beginning of the dialog with EEG monitoring she had irregular EEG activity without generalized epileptiform graphoelements. During the dialog about contentions with her daughter and sexual potency of her husband continues in EEG irregular activity. After eyes closing emerge about 1 second lasting spike wave complex together with continuing dialog. Painful questions repetitively provoked epileptic activity and determined sharp alpha waves of high amplitude. During direct questions on sexual life are manifested sharp waves in the form of spikes and slowing of theta rhythm (figure 1). Similar findings in epileptic patients are also shown in the study of Heath [16] or Stevens [29].

We conclude that the hypothesis in this short paper has its aim to show that parallel distributed processing represents model which in the connection with deterministic chaos can be used for explanation of correlation between manifestations of some dissociative states and burst EEG activity. This theoretical explanation may represent many perspectives for further study of the mind-brain relationship in the study of psychiatric diseases. As an example we suggest the problem of localization of mental representations which have important consequences for the study of epilepsy and generally for the study of the neural dynamics in many psychiatric disorders.

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