

Editorial Άρθρο Σύνταξης

Brain functional connectivity and the pathophysiology of schizophrenia

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In the last decade there is extensive evidence to suggest that cognitive functions depending on coordination of distributed neuronal responses are associated with synchronized oscillatory activity in various frequency ranges suggesting a functional mechanism of neural oscillations in cortical networks. In addition to their role in normal brain functioning, there is increasing evidence that altered oscillatory activity may be associated with certain neuropsychiatric disorders, such as schizophrenia. Consequently, disturbances in neural synchronization may represent the functional relationship of disordered connectivity of cortical networks underlying the characteristic fragmentation of mind and behavior in schizophrenia.

In recent studies the synchronization of oscillatory activity in the experience of characteristic symptoms such as auditory verbal hallucinations and thought blocks have been studied in patients with schizophrenia. Studies involving analysis of EEG activity obtained from individuals in resting state (in cage Faraday, isolated from external influences and with eyes closed).

In patients with schizophrenia and persistent auditory verbal hallucinations (AVHs) observed a temporary increase in the synchronization phase of α and high θ oscillations of the electroencephalogram (EEG) compared with those of healthy controls and patients without AVHs. This functional hyper-connection manifested in time windows corresponding to experience AVHs, as noted by the patients during the recording of EEG and observed in speech related cortical areas. In another study an interaction of theta and gamma oscillations engages in the production and experience of AVHs. The results showed increased phase coupling between theta and gamma EEG rhythms in the left temporal cortex during AVHs experiences.

A more recent study, approaches the thought blocking experience in terms of functional brain connectivity. Thought blocks (TBs) are characterized by regular interruptions of the flow of thought. Outward signs are abrupt and repeated interruptions in the flow of conversation or actions while subjective experience is that of a total and uncontrollable emptying of the mind. In the very limited bibliography regarding TB, the phenomenon is thought to be conceptualized as a disturbance of consciousness that can be attributed to stoppages of continuous information processing due to an increase in the volume of information to be processed. In an attempt to investigate potential expression of the phenomenon on the functional properties of electroencephalographic (EEG) activity, an EEG study was conducted in schizophrenic patients with persisting auditory verbal hallucinations (AVHs) who additionally exhibited TBs.

Phase synchronization analyses performed on EEG segments during the experience of TBs showed that synchrony values exhibited a long-range common mode of coupling (grouped behavior) among the left temporal area and the remaining central and frontal brain areas. These common synchrony-fluctuation schemes were observed for 0.5 to 2 s and were detected in a 4-s window following the estimated initiation of the phenomenon. The observation was frequency specific and detected in the broad alpha band region (6–12 Hz).

The introduction of synchrony entropy (SE) analysis applied on the cumulative synchrony distribution showed that TB states were characterized by an explicit preference of the system to be functioned at low values of synchrony, while the synchrony values are broadly distributed during the recovery state. The results indicate that during TB states, the phase locking of several brain areas were converged uniformly in a narrow band of low synchrony values and in a distinct time window, impeding thus the ability of the system to recruit and to process information during this time window.

The results of this study seem to have greater importance on neuronal correlation of consciousness. The brain is a highly distributed system in which numerous operations are executed in parallel and that lacks a single coordinating center. This raises the question of how the computations occurring simultaneously in spatially segregated processing areas are coordinated and bound together to give rise to coherent percepts and actions. One of the coordinating mechanisms appears to be the synchronization of neuronal activity by phase locking of self-generated network oscillations. This led to the hypothesis that the cerebral cortex might exploit the option to synchronize the discharges of neurons with millisecond theoretical formulations of the binding-by-synchrony hypothesis were proposed earlier by Milner (1974), but the Singer lab in the 1990s was the first to obtain experimental evidence supporting the potential role of synchrony as a relational code.

The results concerning the functional connectivity of the brain during TBs further support the hypothesis of phase synchronization as a key mechanism for neuronal assemblies underlying mental representations in the human brain.

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