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Interbrain Synchronization and Multilayer Hyper brain Networks when Playing Guitar in Quartet

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Abstract : Neurophysiological evidence suggests that the physiological states of the system are characterized by specific network structures and network topology dynamics, demonstrating a robust interplay between network topology and function. It is also evident that interpersonal action coordination or social interaction (e.g., playing music in duets or groups) requires strong intra- and interbrain synchronization resulting in a specific hyper brain network activity across two or more brains to support such coordination or interaction. Such complex hyper brain networks can be described as multiplex or multilayer networks that have a specific multidimensional or multilayer network organization characteristic for superordinate systems and their constituents. The aim of the study was to describe multilayer hyper brain networks and synchronization patterns of guitarists playing guitar in a quartet by using electroencephalography (EEG) hyper scanning (simultaneous EEG recording from multiple brains) and following time-frequency decomposition and multilayer network construction, where within-frequency coupling (WFC) represents communication within different layers, and cross-frequency coupling (CFC) depicts communication between these layers. Results indicate that communication or coupling dynamics, both within and between the layers across the brains of the guitarists, play an essential role in action coordination and are particularly enhanced during periods of high demands on musical coordination. Moreover, multilayer hyper brain network topology and dynamical structure of guitar sounds showed specific guitar-guitar, brain-brain, and guitar-brain causal associations, indicating multilevel dynamics with upward and downward causation, contributing to the superordinate system dynamics and hyper brain functioning. It is concluded that the neuronal dynamics during interpersonal interaction are brain-wide and frequency-specific with the fine-tuned balance between WFC and CFC and can best be described in terms of multilayer multi-brain networks with specific network topology and connectivity strengths. Further sophisticated research is needed to deepen our understanding of these highly interesting and complex phenomena.

Keywords : EEG hyper scanning, intra- and interbrain coupling, multilayer hyper brain networks, social interaction, within- and cross-frequency coupling
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