The hidden structure of social brain: Analysis of multi-brain graphs

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We are our brains, the idea originating from Hippocrates, becomes increasingly recognized in the era of massive brain imaging and modern science of data analysis. Recent research considerably increased our knowledge about the fascinating brain functional capabilities, recognizing the brain areas responsible for different activities, information processing, emotions, a comprehension of languages, time, distance, numbers, as well as the origin of various diseases. Mapping the imaging data onto networks and the objective analysis by graphs theory has provided a significant leap in the contemporary science of the brain. Currently a consensus exists about the networks of anatomical relationships, which are a basis for more complex and dynamically variable graphs of the brain functional connections.The application of statistical physics to research brain functional stability, the onset of a disease or the memory has a long tradition. The problem of the social brain considers the social impact onto brain functions and the neuronal basis of the social conduct of humans. In contrast to the single brain imaging, the investigations of the social brain involve simultaneous recordings of a group of people during a particular communication. Besides, the complexity of the social brain is that it involves different brain areas that communicate, depending on the type of inputs and their precise contents (emotional, cognitive). Recently, we have introduced a new methodology [1] based on the use of the algebraic topology of graphs to investigate the functional brain connections which underly the social brain of the participating individuals and the inter-brain links in the aggregate multi-brain graphs. The simultaneously recorded EEG data [2] are mapped onto a correlation graph; we then apply the techniques of algebraic topology to detect the higher organized structures of the cliques of all order and their complexes. In this talk, we will demonstrate how different topology measures of such structures distinguish between the individual brain activity patterns and various inter-brain coordinations and how they agree with the participant's self-rating experience on the level of knowledge and understanding of the subject, and the speaker's narrative qualities and attractiveness. We also discuss the dynamical features of these connections and the capabilities of the methodology for other applications.

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