“TMS-EEG connectivity analyses to explore cortical networks”

Alberto Pisoni, PhD, Università degli Studi di Milano – Bicocca, Dipartimento di Psicologia

The TMS-EEG co-registration system allows assessing the cortical excitability level of the stimulated brain region and of brain sites that are connected to it. Through the analysis of the spread of the neural signal, indeed, TMS-EEG can reconstruct how and when different cortical sites are communicating. This measure has been related to effective connectivity, since the perturbating stimulus is delivered through a TMS pulse, thus indicating where the signal is coming from. Furthermore, the degree of communication between regions of the cortex starting from the stimulation of a specific region, can differentiate between degrees of consciousness induced by physiologic changes, as during sleep, or pathological conditions, as in disorders of consciousness, as well as external modulations, as in pharmacological anesthesia. Nevertheless, more subtle changes induced by neurophysiologic activations due to cognitive processing may be difficult to capture with such measure. Critically, brain states and cognitive processing have been linked to specific patterns of brain oscillatory activity, analyzed both in the time frequency domain as increases or decreases of power in specific EEG frequency bands, or using functional connectivity measures: when the features shared by two regions on their rhythmic activity are stable over time and trials, a certain degree of communication between the two cortical sites is supposed. There are, however, several different functional connectivity measures, each one with its strengths and weaknesses, and in the TMS-EEG literature, very few examples of the application of these indicators are present. One of the most critical aspects of functional connectivity analyses is the problem of ghost connections or of separating two connections which are near in space. Furthermore, the TMS pulse introduces a strong amount of information in a very specific cortical site, which usually is the one in which researchers are interested into, thus increasing the possibility of highlighting fake connections between the TMS hotspot and neighboring regions due to signal spread. In this presentation, I will show through a re-analysis of old TMS-EEG data, how the application of different measures of functional connectivity can influence results, with a suggestion of which could be the best suited approach for computing functional connectivity with this technique. Finally, I will report how functional connectivity can be useful in TMS-EEG experiment to track changes induced by external modulations as well as by cognitive processing.