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The role of short and long range synchrony in motor function: Evidence from magnetoencephalography (MEG) and clinical applications

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MEG has the capacity to reveal changes in the synchrony of ongoing cortical oscillations between and within spatially distinct brain areas. The prevailing thought is that these changes are indicative of modulations in the synchrony of neural activity to facilitate or suppress local processing and information transfer. In particular, changes in neural synchrony during motor function have been reported at a wide range of frequencies. Our research goals are (1) to increase our understanding of how neural synchrony is modulated by movement planning, execution and imagined movement in the healthy brain, and (2) to utilize this knowledge to improve the treatment of motor impairment following neurological damage. In this light, we present two studies of neural synchrony in the motor network, with each focusing on synchrony over different ranges. The first study investigates changes in MEG-based measures of long-range synchrony between the performance of a precision motor task and an equivalent rest period. Cortico-cortical coherence and graph theory are utilized to identify the brain areas and frequencies of oscillation that are more synchronous during task performance. The second study capitalizes on the known characteristics of short-range synchrony in the motor network to provide MEG-based real-time neurofeedback about the performance of an imagined unilateral precision movement. Real time magnetic source imaging and spectral analysis are utilized to provide feedback from specific brain areas. Neurofeedback about contralateral and ipsilateral brain activity is provided to half of the subjects over repeated sessions on consecutive days. We investigate the difference in the laterality of brain activity as a function of the provision of neurofeedback. Results from both studies are discussed in the context of improving the recovery of neural networks and motor function following stroke.

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