Presentation Abstract

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Presentation Title:	Disentangling causality of corticomuscular coherence within the sensorimotor loop
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Abstract:	Corticomuscular coherence (CMC) in the beta band (15-30 Hz) expresses the functional coupling between the cortex and the muscles during motor control. Traditionally, CMC was considered a one-way effect of the efferent (motor) pathways. The phase of the CMC expresses the relative time-frequency relationship and is often explained as to result from the efferent delay between the cortex and the muscles. However, in recent years this view is reconsidered as the reported CMC time-delays can not be explained as a pure conduction delay of the efferent pathways. Recent studies demonstrated that the slope of the CMC phase is less negative than would be expected of the efferent pathways alone (negative slopes indicate that the muscle lags the brain) and even becomes positive in some subjects (e.g. Witham et al. 2011, J Physiol). This is a clear indication of a bidirectional coupling between EEG and EMG; in other words: the signals are part of a closed-loop system and CMC originates from the interaction within the sensorimotor loop. Currently, the view that CMC originates from bidirectional coupling is generally accepted. With a modeling study we investigated the effect of the sensorimotor interaction on the phase-frequency relationship of the CMC. The model includes two systems, representing the efferent and afferent pathways modeled as gains and realistic neural time delays. We found that the closed-loop formed by the sensorimotor interaction has a huge effect on the phase-frequency relationship, depending on the relative strength of the afferent pathways. Within the beta band the slope of the phase-frequency relation is reduced (i.e. is less negative than expected for a pure efferent pathway) and has a nonzero intersect. If the afferent pathways are stronger than the efferent pathways a phase advance will result, i.e. the slope can become positive. In conclusion, the phase-frequency relation emerges from the interaction in the sensorimotor loop and here we demonstrated how the relation depends on a complex interaction between the afferent and efferent pathways.

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Keyword(s): COHERENCE

EEG

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