10-14-2012

Neuromagnetic Activity in the Cerebral Cortex is Modulated by Locomotor-Like Movements Produced during Pedaling

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Abstract. Sheila Schindler-Ivens, Ruth Swedler, Brian Schmit, and Sylvain Baillet. Presentation given at the *Neuroscience 2012* conference, 2012.

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Presentation Abstract

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Program#/Poster#: 274.13/JJ11

Presentation Title: Neuromagnetic activity in the cerebral cortex is modulated by locomotor-like movements produced during pedaling

Location: Hall F-J

Presentation time: Sunday, Oct 14, 2012, 1:00 PM - 2:00 PM

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Abstract: Recent work has shown that, during uncomplicated locomotor behaviors such as walking and pedaling, the sensory and motor cortices of the human brain are more active than previously thought. However, the function of these structures is unclear. Some studies suggest that the primary motor cortex (M1) contributes directly to locomotor muscle output. Others indicate that M1 activity during locomotion represents sensory feedback from the moving limbs. In this study we used magnetoencephalography (MEG) to examine human brain activity in the sensory and motor cortices during pedaling. We hypothesized that, if these brain regions are important for controlling locomotion, then the MEG signal would be different during pedaling as compared to rest and would be modulated with the phase of the pedaling cycle. Moreover, if locomotor-related brain activity is caused solely by sensory feedback, then the MEG signal would be the same during active and passive pedaling.

Eight individuals pedaled while lying supine on a MEG scanner bed. MEG scans were performed during three conditions: rest, active pedaling, passive pedaling. Distributed source modeling was used to determine the cortical origins of task-dependent neural activity. Four regions of interest were examined: M1, primary sensory cortex, premotor area, supplemental motor area. For each region and each condition, we examined the mean power of the MEG signal in the alpha, beta, and gamma frequency bands. We also examined modulation of beta band power across the pedaling cycle.

Mean power decreased during pedaling as compared to rest in the alpha and beta bands, but not in the gamma band. This decrease in power was evident during active *and* passive pedaling. Beta band power was modulated across the pedaling cycle. During active and passive pedaling, deep fluctuations in beta power were observed at approximately twice the pedaling frequency. These fluctuations were likely related to the phase of the pedaling cycle, as similar fluctuations were not apparent during rest. Phase-dependent modulation of beta power was larger during passive as compared to active pedaling. All of these observations were evident in all four regions of interest.

Results suggest that the sensory and motor cortices of the human brain contribute to locomotor-like movements. Changes in beta power across the pedaling cycle suggest that activity in the brain regions examined may help shape the phasic pattern of muscle activity that is characteristic of locomotion. Differences in beta power modulation during active and passive pedal suggest that the sensory and motor cortices may be involved in motor output *and* sensory processing during locomotion.

Disclosures: **S.M. Schindler-Ivens:** None. **R. Swedler:** None. **B. Schmit:** None. **S. Baillet:** None.

Keyword(s): WALKING

MEG

IMAGING

Support: NICHD-MCMRR (K01HD00600693)

[Authors]. [Abstract Title]. Program No. XXX.XX. 2012 Neuroscience Meeting Planner. New Orleans, LA: Society for Neuroscience, 2012. Online.

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