Cortical Activation in an Asymmetric Bimanual Task: An EEG Study

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Background

Bimanual asymmetric movements, such as driving a car, are common in everyday life. However, they often take much practice to master, as with playing the piano. However, little is known about their neural mechanism. This study investigated the cortical activation associated with the learning of a bimanual asymmetric task.

Methods

- Six healthy, right-handed subjects performed an asymmetric bimanual task. The subjects’ forearms rested on horizontal manipulanda.
- Subjects were instructed to move their left arm rhythmically to a frequency of 0.75 Hz as smoothly as possible, while their right arm completed discrete reaching between two targets as fast as possible at randomly timed intervals.
- Bimanual symmetric reaching was performed as a control.
- Subjects practiced the task over 10 days and were scheduled to return in 2 months for 3 retention sessions.
- Subjects’ cortical activations were recorded over 3 sessions by 64-channel electroencephalography (Biosemi®).
- The EEG signal was referenced with bilateral mastoids and band-pass filtered at 0.5-30 Hz.
- Event-related potentials (ERP) were aligned with the cue onset and divided into epochs. Epochs with movement artifacts were rejected.
- The resulting epochs for all 64 channels were averaged.

Results

- Subjects improved performance with practice.
- At session 1, ERP in the premotor area showed a differential neural activity 250 ms after cue onset in the asymmetric condition.
- The ERP became more similar to the symmetric condition at session 10.

- A centralized negativity was noted in the cortical activation maps for the symmetric condition.
- The central negativity appeared in the asymmetric condition in session 10.

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Conclusion

- With practice, subjects were able to learn the bimanual asymmetric task, although the two arms did not reach the level of unimanual performance.
- The EEG data showed task-specific cortical activation during asymmetric bimanual movement in the premotor area.
- Change of ERP over practice suggests that the task-specific cortical activation is associated with performance improvement or learning the bimanual task.
- This study helps to understand the neural mechanism of bimanual movement and its plasticity.
- This study has clinical significance by shedding light on interhemispheric communication. Hemiplegic stroke patients often experience movement difficulties on both their affected and unaffected sides. This is likely due to undesired influence from the lesioned hemisphere.

Ongoing Analyses

1. ERP analysis aligned with movement onset
   - This EEG study focused on the ERP at cue onset.
   - How does the ERP related to movement onset differ from cue onset across tasks and learning?

2. Task-related interhemispheric coherence
   - To what degree is the asymmetric task associated with interhemispheric communication?

3. Correlation between EEG and performance
   - In what way does EEG change depend on behavioral task performance?

References