NeuroImage 13, Number 6, 2001, Part 2 of 2 Parts IDEAL

SENSORIMOTOR

An event-related fMRI study on the time difference between the basal ganglia and the cerebellum during finger movements

Yufeng Zang*†, Xuchu Weng*, Fucang Jia*, Enzhong Li§, Richer Ivry‡

**Laboratory for Higher Brain Function, Institute of Psychology, Chinese Academy of Sciences, Beijing 100101, China*

†Institute of Mental Health, Peking University, Beijing 100083, China

‡Department of Psychology, University of California, Berkeley

§Department of MRI, Shougang General Hospital,Beijing

Introductions:

Studies of the time course of activity in cortical motor areas reveal that activation in the SMA precedes that in M1. While the initial studies involved EEG-based measures (e.g., Kornhuber & Deecke, 1965), this pattern has also been observed with fMRI. For example, Wildgruber et al. (1977) found that the homodynamic response localized to SMA preceded that in M1 by 800 ms during finger movements. In the present study we used event-related fMRI to compare the time course of activation in the basal ganglia and the cerebellum during sequential finger movements.

Methods:

T2* weighted oblique slices covering basal ganglia and cerebellum were collected in 7 young right-handed subjects during performance of two finger tapping tasks. In the simple tapping task, the subjects produced four successive taps with the right index finger at 1.3 Hz. In the sequential tapping task, the four taps were made with different fingers at the same rate. Voxel-based deconvolution and multiple linear regression procedures were used to generate the activation map. The hemodynamic response function (HRF) of each ROI in the basal ganglia and the cerebellum was averaged for further analysis. The peak time, peak magnitude, and signal duration (measured as the Full Width Half Maximum) of the HRF were tested by ANOVA (Task*Laterality*Location, Task: simple vs. sequential; Laterality: left vs. right; Location: basal ganglia vs. cerebellum).

Results:

1) Bilateral basal ganglia and cerebellum were activated in both tasks. 2) Peak Time: Main effects were found for Location ($p<0.0001$). The basal ganglia response was observed prior to the cerebellar response (2.7 ± 0.5 s vs. 3.6 ± 0.7 s). Effects of Task and Laterality were not significant ($p>0.5$). 3) Peak magnitude: No significant effects were observed for all three factors. 4) Signal duration: Significant effects were observed for Task ($p<0.008$) and Location ($p<0.009$). In both areas, the drop off in the signal was delayed in the complex task and the response in the cerebellum persisted for a longer time in the cerebellum compared to the basal ganglia (basal ganglia, simple vs. complex: 2.6 ± 0.7 vs. 3.3 ± 0.9 s; cerebellum, simple vs. complex: 3.3 ± 1.7 vs. 4.2 ± 1.0 s).

Discussion and Conclusion:

1) Both left and right sides of the basal ganglia and cerebellum were recruited when subjects produced either simple or complex finger movement sequences. 2) The earlier hemodynamic response of basal ganglia may be related to its participation in the initiation of movements, consistent with the single cell recording report (Cheruel et al 1994). The difference may also be related to task-independent differences in the hemodynamic response of these regions, rather than reflect latency differences in the neural responses. The extended activation in the cerebellum may reflect the role of this structure in the continuous control of the movements. 3) Complexity was manifest as an increase in the duration of the hemodynamic response rather than as an increase in the intensity of the response.