Cortical Sources of ERP during Prosaccade and Antisaccade Eye Movements with Realistic Source Models
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Abstract
The cortical sources of event-related potentials (ERPs) using realistic source models were examined in a prosaccade and antisaccade paradigm. College age participants were presented with a preparatory stimulus and a target that indicated the direction of the eye movement that was to be made. In some blocks, a cue was given on the preparatory stimulus where the target was to be presented, and in other blocks no cue was given. In Experiment 1, the prosaccade and antisaccade trials were presented randomly within a block. In Experiment 2, prosaccade and antisaccade trials were presented in the same block, and trials were presented in separate blocks with a cue type of eye movement. There was a central negative slow wave occurring prior to the target, a slow positive wave over the parietal scalp prior to the saccade, and a parietal positive potential immediately prior to saccade onset. Cerebral source analysis of the ERP components showed a common set of sources in the ventral anterior cingulate and related frontal gyri for the prosaccade, positive over the parietal scalp and negative in the superior temporal and parietal scalp areas contralateral to the direction of the eye movement. These results suggest that the blocked prosaccade and antisaccade trials result is preparation or set effects that decrease reaction time, suppress some error effects, and are based on computational parallel-control brain areas.

Methods

Participants
- Experiment 1: 19 young adults (20 to 41, mean age 25 years)
- Experiment 2: 11 young adults (19 to 34, mean=25 years)
- All participants had 3.0T structural MRI (3D, T1-weighted, 1.0 mm slices, 256 x 159 x 256 FOV)
- Electrode placement maps for the EGI 128-Channel SensorNet, placed individualized fiducial points on 3-D rendered scalp from MRI; did Cohens-Pt-Drift algorithm for fiducial and average electrode placement map.
- Segmentation of structural MRI, including GM, WM, CSF, bone (skull), scalp, eyes, muscles, nasal cavity
- Individual stereotactic atlases, based on "Hammers", LOI Probabilistic Brain Atlas, Harvard-Oxford, and Lobar atlases; defined ROI, theoretically important for eye movement control.
- 3D "Finite Element Model" wireframes derived from segmented structural MRI, based on EMSE computer program to inverse model for sLORETA.

Questions
- What are the presaccadic ERP components occurring for prosaccade and antisaccade eye movements? What are the cortical sources of these components?
- What are the effects of "blocked" trials, compared with "mixed-choice" trials, on the ERP/cortical sources for these eye movements?
- How can ROI-based, realistic FEM head models, be used to access cortical sources of eye movement control?

Results

The presaccadic ERP wavelet was localized to the orbital frontal gyrus and ventral anterior cingulate cortex. It was larger for cued eye movements. The presaccadic parietal slow wave was larger for antisaccade than for prosaccade eye movements.
- Blocked trial presentations reduced the effect of cueing on the RT, i.e., seems to be a response set.
- Negative slow wave is larger on blocked trials for antisaccade eye movements, and this effect is lateralized in parietal and central areas contralateral to the eye movement.
- On blocked trials, there were larger cortical activity contralateral to the eye movement, preceding the eye movement, in areas around the lateral frontal pole.
- Many of the presaccadic/antisaccade eye movement brain activity found in prior studies, especially MNI, is due to blocked trials presentations. The ERP evidence suggest there is a response set for blocked antisaccade eye movements (reduced cueing effects; enhancement of spatial orienting system contralateral to eye movement).