Effective Connectivity Changes During Visual and Auditory Selective Attention Tasks

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INTRODUCTION

Superior parietal areas are active when stimuli require a response [1], and the temporoparietal junction has been implicated in selective attention to stimuli [1,2]. That suggests that the inputs from primary sensory regions to these areas may vary depending on which stimuli are relevant to the subject. We developed a task requiring selective attention to particular stimuli, and tested how the influences of primary sensory areas on parietal areas changed depending on which stimuli required a response.

METHODS

Three subjects received simultaneous visual and auditory stimuli, arranged in a random-length block design. The visual stimulus consisted of the word "press" displayed either to the right or to the left of a central fixation point; the auditory stimulus was the word "press" spoken in either the left ear or the right ear, not necessarily matching the visual stimulus. Every 3.5 seconds, a sequence of three stimuli was presented, and the subject was instructed to press the right and left response buttons in imitation of the sequence of the stimuli. In two sessions, the subject was to respond to the visual stimuli and ignore the auditory stimuli; in the other two sessions, the reverse. Functional MRI data were acquired with a gradient-echo EPI sequence at 2 s TR, 40 ms TE, 85 degree flip angle, and 3.75 x 3.75 x 7 mm^3 voxels. Data were corrected for slice timing, coregistered, smoothed, and analyzed using the SPM99 software. Region-of-interest time series were extracted using a spherical Gaussian-weighted average around the maximally active voxel in each area. Effective connectivity between primary sensory areas and superior parietal areas was measured using two-stage least squares [3] with the model shown in Figure 1. Individual connectivity measurements from each subject were averaged together to yield a single estimate for each connection in each response condition, and the difference in connection strength between the response conditions was calculated.

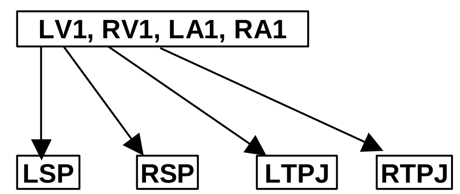

Figure 1: The model used to measure effective connectivity. V1 and A1 are primary visual and auditory cortex; SP is the superior parietal area; and TPJ is the temporoparietal junction.

RESULTS

Cortical activity was observed in all subjects in the supplementary motor area; bilateral premotor areas; left primary motor cortex; bilateral primary and secondary visual and auditory regions; bilateral temporoparietal junction; and bilateral superior parietal areas (Figure 2). Connections from visual areas to parietal areas were predominantly higher in strength during the respond-to-visual condition: the mean difference (visual minus auditory) was 0.03 for the temporoparietal junctions, and 0.082 for the superior parietal areas. Connections from the right auditory area to parietal areas were predominantly higher in strength during the respond-to-auditory condition: the mean difference (visual minus auditory) was -0.029 for the temporoparietal junctions and -0.073 for the superior parietal areas.

Figure 2: Areas activated by the combined auditory and visual stimuli in one subject. From left to right: Primary auditory cortex and premotor areas; Superior parietal and temporoparietal regions; Primary visual cortex.

CONCLUSION

Functional BOLD response was observed as expected in superior parietal areas and the temporoparietal junction, which we attribute to selection of stimuli for response. Mean changes in connectivity between primary sensory regions and the parietal regions suggest that the parietal regions were selectively integrating the stimuli that guided the motor response.

REFERENCES

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