

Single subject MTL activation detected using a self-paced fMRI semantic categorization paradigm

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Purpose

A functional magnetic resonance imaging (fMRI) study was performed to evaluate whether a self-paced, in contrast to a classical fixed-paced, semantic encoding paradigm is capable to elicit mesiotemporal lobe activation.

Methods

21 healthy volunteers aged between 23 and 47 years, entered in this study. They performed a similar semantic classification paradigm twice, one in a fixed paced and once in a self-paced manner. During each experiment, semantic encoding (S, activation task) was contrasted with perceptual encoding (P, baseline task). Data analysis comprised a random-effects group analysis to evaluate the influence of stimulus-pacing on the observed activation pattern, an individual region-of-interest (ROI) analysis to investigate single-subject MTL activation, and the calculation of the lateralization index (LI), being the relative difference between the number of activated voxels between the left and right MTL ROI.

Results

group analysis

Self-paced semantic encoding consistently activated the mesiotemporal lobe structures, including the parahippocampal gyrus, the hippocampus and the fusiform gyrus, predominantly on the left side.

The fixed-paced design failed to detect supra-threshold MTL activation.

Individual ROI analysis

The self-paced experiment resulted in significant MTL foci in 19 of 21 subjects. In 15 of these the activation was left-lateralised, in 3 bilateral, and 1 demonstrated stronger right-sided activation.

Fixed-pacing detected significant MTL activation in only 4 of 21 subjects.

Discussion

Previous fMRI studies investigating semantic processing resulted in contradictory results regarding the activation of mesiotemporal lobe structures. Therefore, the MTL involvement remains a matter of discussion. These experiments have typically used fixed-paced blocked designs.

Fixed-paced trials, however, can be rather slow and leave time and resources for multiple confounding factors to intrude. In contrast, during a self-paced trial the stimuli are presented rapidly, dependend of the subjects' reaction time. This chalanges the systems of interest and leaves few cognitive resources for non-task related processes to occur.

Moreover, self-pacing automatically implies a distibuted sampling over peristimulus time. Others have shown that varying the timing of data acquisition relative to stimulus presentation, can be critical to detect essential language areas.

Conclusion

This study illustrates the impact of stimulus pacing on the detection of MTL structures using a semantic encoding paradigm. Only the self-paced semantic classification paradigm was capable of detecting consistent single-subject MTL activation. These results can enter the debate concerning the MTL involvement in semantic processing. Furthermore, we will study the use of this paradigm to identify critical language areas during the pre-surgical evaluation of patients with focal brain lesion, and in patients suffering from temporal lobe epilepsy.

References

1. Daselaar MD, Veltman D, Rombouts SARB, Raaijmakers GW, Lazeron RHC, Jonker C. Deep processing activates the medial temporal lobe in young but not in old adults. *Neurobiology of aging* (2003) in press
2. Price C.J., Veltman D.J., Ashburner, J, Josephs O., Friston K.J. The critical relationship between the timing of stimulus presentation and data acquisition in blocked designs with fMRI. *Neuroimage* 10:36-44 (1999).
3. D'Esposito MD, Zarahn E., Aquirre G.K., Shin R.K, Auerbach R., Detre J.A. The effect of pacing of experimental stimuli on observed functional MRI activity. *Neuroimage* 6:113-121. 1997
4. Veltman DJ, Mechelli A, Friston KJ, Price CJ. The importance of distributed sampling in blocked functional magnetic resonance imaging designs. *Neuroimage*. 2002 ;17(3):1203-6.