Temporal Lobe Activation in Picture-Naming - Applications to fMRI Assessment in Epilepsy

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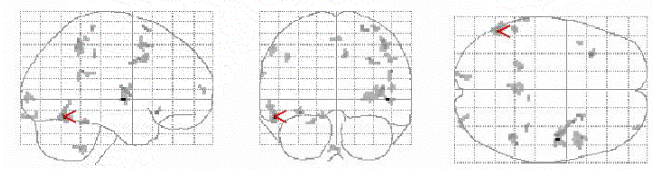
Introduction: A promising application of fMRI is the evaluation of brain activity in temporal lobe epilepsy (TLE). In particular, fMRI can provide an assessment method for evaluating outcome in different surgical treatments for TLE. Two main surgical approaches are typically used in TLE: 1) a selective amygdalohippocampectomy, in which the amygdala, hippocampus, and parahippocampal gyrus are resected; and 2) an anterior temporal lobe resection, in which mesial structures along with the lateral neocortex are resected. The key clinical issue concerns whether or not a more restricted resection offers advantages in terms of functional outcome. To evaluate outcome, it is important to localize stimulus-evoked activity linked to intact sensory, perceptual, and cognitive processing in the neocortical temporal regions that have been spared. We have developed a neuropsychological task that is capable of eliciting functional activation in the temporal lobes. Most fMRI studies involving cognition are concerned with identifying regions of the brain that are activated by a particular cognitive task. The current situation requires the reverse – develop a cognitive task that activates the temporal neocortex. In the current study, we hypothesized that temporal regions could be activated in healthy controls by a picture-naming task that requires semantic judgments and that the pattern of these results would correspond with the pattern of the behavioural results.

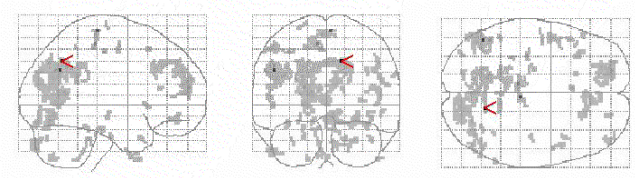
Methods: The picture-naming task used in this study is a well-known semantic judgment task with established norms. We used the same procedures and set of standardized visual stimuli (1) employed by Damasio et al (2). The task was presented using a mixed event-related/block design to maximize task related activation. The stimulus blocks were organized in a 2x2 parametric design with Stimulus Material (Animate/Inanimate) and Word Type (Instance/Category) as factors. The Word Type factor varied the graded engagement of cognitive effort/activation by manipulating whether the word described either an instance of the object or the category to which the object belonged. The picture/word pairs were presented in two sessions of 10 blocks each (10 stimuli per block), which resulted in 5 blocks per experimental condition (10 blocks/factor). Within each block the stimuli were presented using an inter-trial interval of 3 seconds (fixation 1-s, picture/text pair – 2s) with a 15s relaxation period after each block. Subjects responded with a button press, to indicate whether a word presented after the picture matched or did not match the picture.

MRI: We used a General Electric (Waukesha, WI) 1.5T Signa LX MR scanner equipped with Echospeed actively-shielded gradient coils (22mT/m, 120 T/m/s). The functional MRI data were obtained using a single shot gradient-recalled-echo EPI sequence with TR/TE = 2000/40 ms (flip angle = 70 deg.). Whole-brain imaging was performed with 22 coronal slices, 6 mm thick, with a 1 mm gap between slices, a 240 mm FOV, and a 64x64 matrix. There were two acquisition sessions for each task, with 235 volumes/session Data preprocessing and activation maps were generated using SPM2. Picture-naming factors (counterbalanced, with embedded conditions) were evaluated on the basis of the t-contrast maps for activation differences between conditions.

Results and Discussion: Reaction time and accuracy data showed that Stimulus Type and Word Type contributed additively to task difficulty. In the Stimulus Type comparison, animate objects generated longer responses and lower accuracy scores, while in the Word Type comparison; category naming was slower and less accurate than instance naming. Analysis of the fMRI data revealed differences in both animate vs. inanimate and instance vs. category comparisons. In the Stimulus Material comparison, animate objects elicited greater activation than inanimate objects, and in the Word Type comparison, category naming elicited greater activation than instance naming. In addition, the activation maps indicated that these two factors appeared to interact additively. The figure depicts the two extreme cells in this interaction, with Animate/Category showing the greatest extent of activity, and Inanimate/ Instance the least. Interestingly, temporal lobe activation was present in all contrasts, except the Inanimate/Instance contrast. The fMRI results likely reflected the fact that the Inanimate/Instance contrast was the least demanding condition, providing further support for the importance of graded difficulty in an fMRI-neuropsychological task. With respect to assessment, it is critical that the task activates these regions in a manner that is consistent with behavioural results. By linking the fMRI and behavioural results, it will be possible to fully utilize fMRI for assessment of intact function following surgery in TLE. Current research is aimed at optimizing these fMRI assessment methods for application to neocortical regions of interest in the temporal lobe.



Inanimate/Instance



Animate/Category

References:

[1] Snodgrass & Vanderwardt, 1980, J.Exp.Psych. **6**:174-215

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