CONTENT AND FUNCTION WORDS DIFFERENTIATED BY GRAY AND WHITE MATTER ACTIVATIONS

Michele T. Diaz[1,2] and Gregory McCarthy [1,2,3,4]

[1]Brain Imaging & Analysis Center, [2]Dept. of Psychological & Brain Sciences, Duke University

[3]Dept. of Radiology, Duke University Medical Center, [4]Dept of Veterans Affairs, Durham NC

1 INTRODUCTION

Content and Function words differ in their purpose and semantic content; differential neural bases for such words are supported by previous research (Friederici et al., 2000). We investigated processing of these words using functional Magnetic Resonance Imaging (fMRI). Previous fMRI studies investigating semantic processing involved passive reading, an explicit semantic task, or comparisons across tasks (e.g. Petersen et al., 1990, Binder et al., 1997). While these manipulations involve semantic processing, it is likely that other processes are also involved (e.g. strategic processes, intrusive thoughts, differential attentional demands). In the present experiment, a stream of random letter strings (2/sec) was displayed, to which participants performed a matching task. Incidental to the overt task, open and closed class words were interspersed randomly among nonwords (1/12-15sec). The nonword baseline served as a control condition for orthographic and letter level processing. The task ensured participant engagement while limiting strategic processing of critical stimuli. The stimuli were contrasted to investigate activation to 1) word and nonword processing and 2) levels of semantic processing. An inverse spiral acquisition sequence was utilized for improved recovery of signal from anterior temporal areas, which have been linked to semantic processing through lesion studies. Areas that differentiated word classes were temporal, parahippocampal, and longitudinal fasciculi, with greater content than function word activation. Most novel, were the bilateral longitudinal fasciculi activations, which extended anteriorly, possibly indicating more extensive processing and functional connectivity for content words. Several analyses limit the possibility that these activations were due to artifact.

2 METHODS

Subjects

- 16 young adults (8 female; mean age =22.25)
- Right handed
- Native English speakers

Stimuli

- 75 Content words (e.g. ##AIRPORT###)
- 75 Function words(e.g. ##NOWHERE###)
- Nonword baseline (2/sec; approx 7000)
- Words were equated for frequency
- All stimuli were equated for length

Functional Imaging Parameters (4.0T)

- Sagittal Localizer images (6; T1-weighted)
- Full-brain axial spoiled grass images (3D SPGR; T1-weighted)
- Inverse spiral functional images (34 oblique axial slices)
  - TR: 1.5 sec (TE: 5.3ms, Flip Angle: 60°)
  - Voxel Size: 3.75mm^2 (64^2 matrix; 24cm FOV)

Preprocessing

- Data were temporally aligned to correct for slice acquisition order within a TR and motion corrected.
- Data were spatially normalized (MNI) and spatially smoothed.
- All preprocessing steps were performed using SPM99.

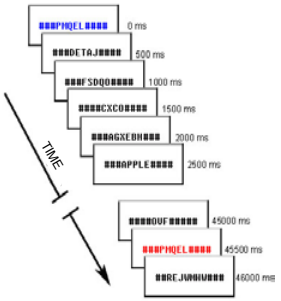
Voxel-based Analyses

- Voxel-based analyses were conducted using custom MATLAB scripts
- For each trial of interest, an epoch, time locked to stimulus onset (-3 sec to +13.5 sec) was selected and trials were averaged.
- The average epoch was correlated at each voxel with a canonical hemodynamic response to derive a t-statistic.
- t-statistics from each subject were submitted to a random effects analysis.

Region of Interest (ROI) Analyses

- To ensure that white matter activations originated in white matter, regions of interest were drawn on each subject's individual anatomy.
  - Splenium of the Corpus Callosum
  - Bilateral Longitudinal Fasciculi

3 EXPERIMENTAL MANIPULATION



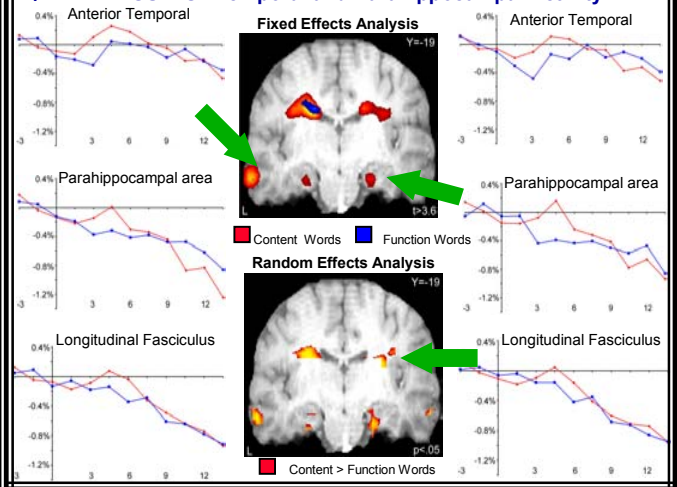
Matching Task

- The purpose of the task was to engage working memory of nonwords and limit elaboration of content and function word processing.
- Participants were instructed to:
  - View the nonword stream
  - Remember the nonwords in blue
  - Decide whether the red nonword matched the previous blue nonword.
- The task was incidental to the critical stimuli.

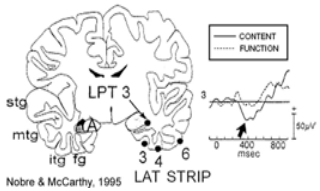
Critical Stimuli

- 75 content and 75 function words
- Presented once every 12-15 seconds.

4 fMRI RESULTS –Temporal and Parahippocampal Activity



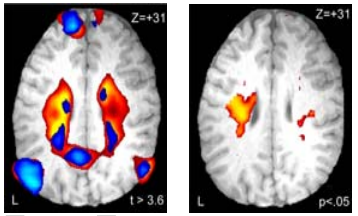
5 PREVIOUS RESULTS – Parahippocampal Area



- Previous research with intracranial recordings suggests that the parahippocampal area differentially responds to content and function words.
- This area shows an N400 like response, which is larger for content than function words.

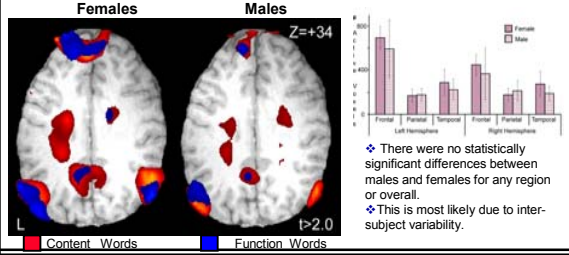
6 RESULTS – White Matter Activity

Longitudinal Fasciculi Activations



- Content words differentially activated longitudinal fasciculi.
- Activations originated in white matter as evidenced by anatomically based ROI analyses.

7 COMPARISON BY SEX



- There were no statistically significant differences between males and females for any region or overall.
- This is most likely due to inter-subject variability.

CONCLUSIONS

- Temporal, parahippocampal and white matter differentiated conditions.
- Several analyses limit the possibility that white matter activations were due to artifact.
- There was bilateral patterns of activation, with greater left than right hemisphere activity.
- There were no significant differences between males and females.

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