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ScienceDirect

Procedia Social and Behavioral Sciences 6 (2010) 92–93

Procedia
Social and Behavioral Sciences

Academy of Aphasia 2010

Neural Substrates of Naming Following Semantic Verification in Aphasia

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Introduction

Semantic verification tasks can facilitate naming in healthy and aphasic individuals, however, the neurocognitive mechanisms involved are unclear. This study examined the neural mechanisms underpinning short and long-term semantic facilitation of naming in two individuals with anomia.

Methods

Two right-handed, 59 year-old stroke patients and a 56 year-old control participated. P1 was 3.7 years post stroke with a large distributed lesion within the fronto-temporal region extending into the parietal lobe, presenting with mild anomia. P2 was 2.7 years post stroke with a focal temporal lobe lesion extending to the temporo-parietal junction, presenting with moderate anomia.

Stimuli for patients, consisted of two sets of pictures (Long-term facilitation, LTF; Short-term facilitation, STF) unable to be named at baselines, and one set (Unfacilitated) consistently named at baselines. All participants completed two facilitation sessions within a week prior to fMRI, during which LTF items were presented on three occasions with a semantic yes/no question (e.g., does it bark?). During fMRI, all stimuli sets were presented for overt naming, however, STF items were initially presented with a semantic question prior to overt naming. Preliminary whole brain analyses ($p < 0.001$, uncorrected, minimum 5 voxel cluster size) are reported.

Results

Analysis for the control revealed decreased activity for LTF versus Unfacilitated in the left middle temporal gyrus (MTG, $Z = 3.91$), while increased activity was observed in the left precuneus ($Z = 3.32$) and right angular gyrus ($Z = 3.46$). Decreased activity for STF versus Unfacilitated was observed in the MTG ($Z = 3.81$) and middle temporal pole ($Z = 3.46$), right inferior frontal operculum ($Z = 3.77$), and bilateral dorsolateral prefrontal cortex (Zs > 3.59).

Both patients demonstrated an increase in naming accuracy (P1, 68% LTF, 75% STF; P2, 64% LTF, 33.3%

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1877-0428 © 2010 Published by Elsevier Ltd.
doi:10.1016/j.sbspro.2010.08.047

STF). For P1, LTF versus Unfacilitated showed decreased activity in the right cuneus (Z = 3.58), right angular gyrus (Z = 3.43) and left precuneus (Z = 3.25), while STF versus Unfacilitated showed increased bilateral superior frontal gyri activity (Z =3.65 & 3.53). For P2, increased activity for STF versus Unfacilitated was observed in the right supramarginal gyrus (Z = 3.54) and inferior frontal operculum (Z = 3.36). STF also showed increased activity compared to LTF in the left anterior cingulate gyrus (Z = 3.51) and bilateral inferior frontal gyri (Zs > 3.3).

Conclusions

For the control, long-term facilitation was consistent with a priming effect through semantic temporal mechanisms, and increased visuospatial imagery and attention. Short-term facilitation was consistent with a similar temporal mechanism and reduced attentional demands. For P1, long-term facilitation was consistent with priming of visual representations to compensate for disrupted semantic temporal mechanisms. For short-term facilitation, increased prefrontal activity was consistent with increased reliance on working memory and attentional mechanisms. For P2, greater supramarginal activity for short-term facilitation was consistent with increased attentional semantic processing, while compared to long-term facilitation, short-term facilitation engaged regions associated with cognitive control.