Changes in task based effective connectivity following rehabilitation in aphasia

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Introduction

The present project examines the neural correlates of language recovery following a theoretically based semantic naming treatment in individuals with aphasia. Our previous work has demonstrated that training the more complex atypical examples (e.g., garlic) of a category (e.g., vegetable) results in generalization to the less complex typical examples (e.g., carrots) in aphasic patients with naming deficits (Kiran, 2007). In this study, we examined task based neural changes and effective connectivity changes in patients who received this semantically based naming treatment.

Methods

Six patients with chronic post stroke aphasia participated in the current study. All participants had suffered a single left hemisphere stroke (one patient had a RH stroke) and demonstrated naming deficits. All participants received a 10 week semantic feature based naming therapy to improve their naming abilities. Therapy was provided on atypical examples of one trained category (e.g., vegetables, clothing or birds) whereas two control categories were monitored; the order of categories was counterbalanced across patients. MR images were acquired on a 3T Phillips scanner. T1 images were acquired with the following parameters: 140 sagittal slices, 1mm³ voxels, TR=8.2ms. BOLD images were collected using the following parameters: 38 axial slices, 3mm³ voxels, TR=2.5s. In each fMRI session, two experimental tasks were conducted; (a) picture naming and (b) semantic feature verification of trained and untrained categories. The oral picture naming task consisted of stimuli identical to those used during treatment, whereas the semantic feature verification task was identical to steps employed during weekly treatment. Functional images were coregistered to structural images and then normalized to the MNI template. Lesion masks were drawn in MRcron on each patient’s T1 image and were used in normalization to minimize deformities during warping (Brett et al., 2001).

Results

Analysis of treatment effect sizes revealed that all patients showed improvements on the trained atypical items (Effect size range 3.33 – 16.17), untrained typical examples (Effect size range 1.1 – 2.86); no changes were observed on the untrained categories. Analysis of post-pre BOLD activation using SPM8 signal revealed patient-specific (based on site of lesion) and task-specific changes in activation as a function of treatment. Across patients, activation that emerged as a function of treatment (post-pre contrasts) on the trained category included LIFGtri, bilateral SFG, LMFG, L precentral and RIFGoper for picture naming; and bilateral MFG, bilateral SFG, bilateral LIFGtri,
bilateral LIFGoper, and LIFGorb for semantic feature verification (see fig 1). Next, regions of interest that were present in both the pre-treatment scans and the post-treatment scans were analysed using dynamic causal modelling (DCM) in SPM8. For each patient, Bayesian model selection (BMS) with driving inputs in the bilateral IFG subregions indicated that the best fit models included LIFGtri as modulating the region and connections.

**Conclusion**

Results from this study show that a feature-based naming treatment results in positive behavioural and neural changes in left and right frontal regions for the trained category in patients. Effective connectivity analysis reveals that across patients, LIFGtri is a highly modulated node in the network that changes as a function of treatment.