Neural mechanisms of verb and sentence production: a lesion-deficit study

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Introduction

Previous studies of sentence processing indicate a left temporo-frontal network for syntactic processing and bilateral temporo-frontal networks for semantic processing (Friederici, 2011). Lesion studies also support involvement of both anterior and posterior regions for sentence comprehension (Dronkers et al., 2004, Caplan et al., 2007). In addition, both normal and lesion studies suggest temporoparietal regions for argument structure processing (Thompson & Meltzer-Asscher, in Press). To date, however, the majority of this work has focused on sentence comprehension, with a paucity of studies examining sentence production. In this study we examined the relationship between topographic and volumetric aspects of brain lesions and verb, argument structure, and sentence production deficits in 31 subjects with stroke-induced aphasia.

Methods

Thirty-one aphasic patients with left hemisphere chronic MCA stroke were administered the Northwestern Assessment of Verbs and Sentences (NAVS, Thompson, 2011). Specific subtest of NAVS used included Verb Naming Test (VNT), Argument Structure Production Test (ASPT) and Sentence Production Priming Test (SPPT). T1-weighted MRI scans of patients were used to quantify lesions using Mricron. Lesions were categorized as anterior (10), posterior (11) and mixed (10). Seven areas were selected as regions of interest (ROIs: IFG, MFG, STG, MTG, SMG, AG, and Insula) based on Pick Atlas (SPM5). Then the lesioned area in each ROI was measured. The effect of the lesion volume in each ROI was tested against performance on each NAVS subtest using regression analysis.

Results

A linear regression analysis revealed that the lesions within IFG, STG and Insula predicted performance on VNT, with poorer performance associated with percent lesion in IFG (t=2.359, p=0.025), STG (t=3.381, p=0.002) and Insula (t=2.434, p=0.021). With regards to SPPT, lower performance on sentence production was predicted by lesion within IFG (t=2.145, p=0.040), STG (t=2.646, p=0.013), SMG (t=2.435, p=0.021) and Insula (t=3.447, p=0.001). Lastly, lesion in the STG was associated with poor performance on the ASPT
(t=2.064, p=0.048).

Discussion

These data show that lesions to both anterior and posterior regions predict sentence production deficits, hence supporting a role for temporal, parietal and frontal regions of the language network for sentence production. Verb production deficits were found to be associated with both the IFG and STG, consistent with Piras & Marangolo (2007). Finally, STG lesions were associated with decreased overall performance on the argument structure production test, consistent with the proposed model of argument structure processing which suggests that the posterior regions (STG/MTG) support integration of the verb with its arguments within sentence context (Thompson & Meltzer-Asscher, in Press). These data extend our knowledge of sentence and verb processing to the production domain.

References


