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Tracking the Arcuate Fasciculus in Patients with Aphasia

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Introduction

The arcuate fasciculus (AF), a white matter tract linking temporal and inferior frontal language cortices, can be disrupted in stroke patients suffering from aphasia. Using diffusion tensor imaging (DTI) tractography it is possible to track AF connections to neural regions associated with either phonological or semantic linguistic processing. The aim of the current study is to investigate the relationship between integrity of white matter microstructure and specific linguistic deficits.

Procedures/Analyses

We report the results of two right-handed 59-year-old patients. P1 (male) was 3.7 years post stroke with a mild anomia and P2 (female) was 2.7 years post stroke with a moderate anomia. A large picture naming battery (476 items) was administered prior to scanning. Of total errors made, P1 produced more semantic errors (46.9%) than phonological (11.7%), and P2 produced more phonological (26.0%) than semantic errors (9.6%). P1 had a large but distributed lesion volume with areas of damage within the fronto-temporal region and extending into the parietal lobe. P2 had a more focal temporal lobe lesion extending to the temporo-parietal junction. A 56 direction (50 b=1159s/mm^2 and 6 b=0) high angular resolution DTI scan was acquired on a 4T MRI scanner. The AF was extracted using the DTI and Fiber Toolbox (Freiburg, Germany), in both left and right hemispheres. The tracking seed points were determined initially using the cytoarchitectonic AF maximum probability map (Anatomy Toolbox, SPM8). Where these points were affected by lesion location in patient data, they were moved to the nearest viable cortical location.

Results

The left hemisphere AF in P1 was less distinct than P2, primarily due to his distributed lesion (see Figure). Both patients showed strong frontal lobe AF projections. While P1 had minor involvement of the posterior superior temporal gyrus (PSTG), P2, with a more focal lesion confined to the temporal lobe, appeared to show no involvement of the PSTG. Additionally, AF projections were shown to extend into the parietal area for both patients, but connections to the supramarginal gyrus were stronger for P1. In the undamaged right hemisphere, P2 showed a more extensive and well defined AF than P1.

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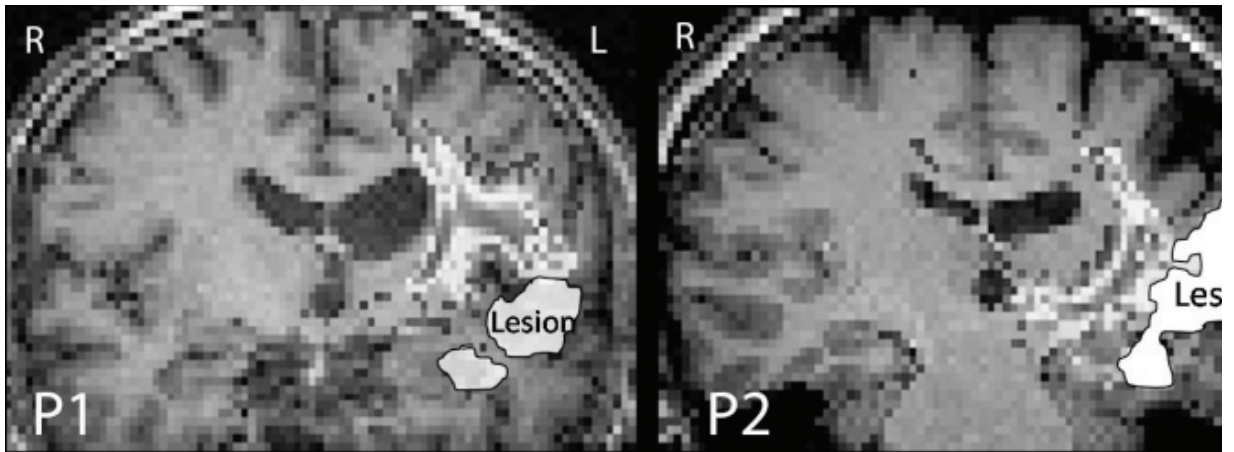
Discussion

Increased semantic versus phonological errors in P1 were associated with greater involvement of posterior regions linked to phonological processing (Indefrey & Levelt, 2004). In contrast, P2 showed increased phonological versus semantic errors and reduced projections to these areas associated with phonological processing. This provides some evidence in support of the proposal that a relationship exists between AF integrity and specific linguistic deficits following stroke.

References

Indefrey, P., & Levelt, W. (2004). The spatial and temporal signatures of word production components. *Cognition*, 92(1-2), 101-144.