Evidence for a Phonological Output Buffer in Posterior Inferior Frontal Sulcus from Repetition Deficits in Primary Progressive Aphasia

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Purpose: This study examined the relationship between performance on repetition tasks and cortical thickness in primary progressive aphasia (PPA). Specifically, we tested for hypothesized input and output phonological working memory buffers in left supramarginal gyrus (SMG) and posterior inferior frontal sulcus (pIFS), respectively. Although prior studies have supported the existence of a phonological buffer in SMG (e.g., Lukic et al., 2019), the current study is the first to test for a phonological output buffer in left pIFS as predicted by the Gradient Order Directions into Velocities of Articulators (GODIVA) model of speech sequencing (Bohland & Guenther, 2006; Guenther, 2016).

Methods: Whole-brain T1-weighted structural scans were obtained from 42 participants diagnosed with PPA. Participants were each grouped into one of three PPA subtypes: non-fluent (n = 13), logopenic (n = 14), or semantic (n = 15). Mean cortical thickness measures for each anatomic region of interest (ROI) were then extracted with FreeSurfer software. All participants also completed three working-memory-dependent tasks: the Repetition subtest from the Western Aphasia Battery (WAB), a forward digit span task, and a backward digit span task. Pearson bivariate correlation analyses were performed to assess the relationship between mean cortical thicknesses in left pIFS and left SMG and a working memory score formed by averaging scores from the three tasks. Exploratory whole-brain Spearman rank-order correlation analyses were also conducted to examine differences in the ROIs that significantly correlated with performance on each task.

Results: Pearson correlations with the average working memory score were significant for both left pIFS (r = .397, p = .009) and left SMG (r = .411, p = .007). Whole-brain exploratory analyses revealed a distinct set of positively-correlated ROIs for each of the three repetition tasks, shown in Figure 1.
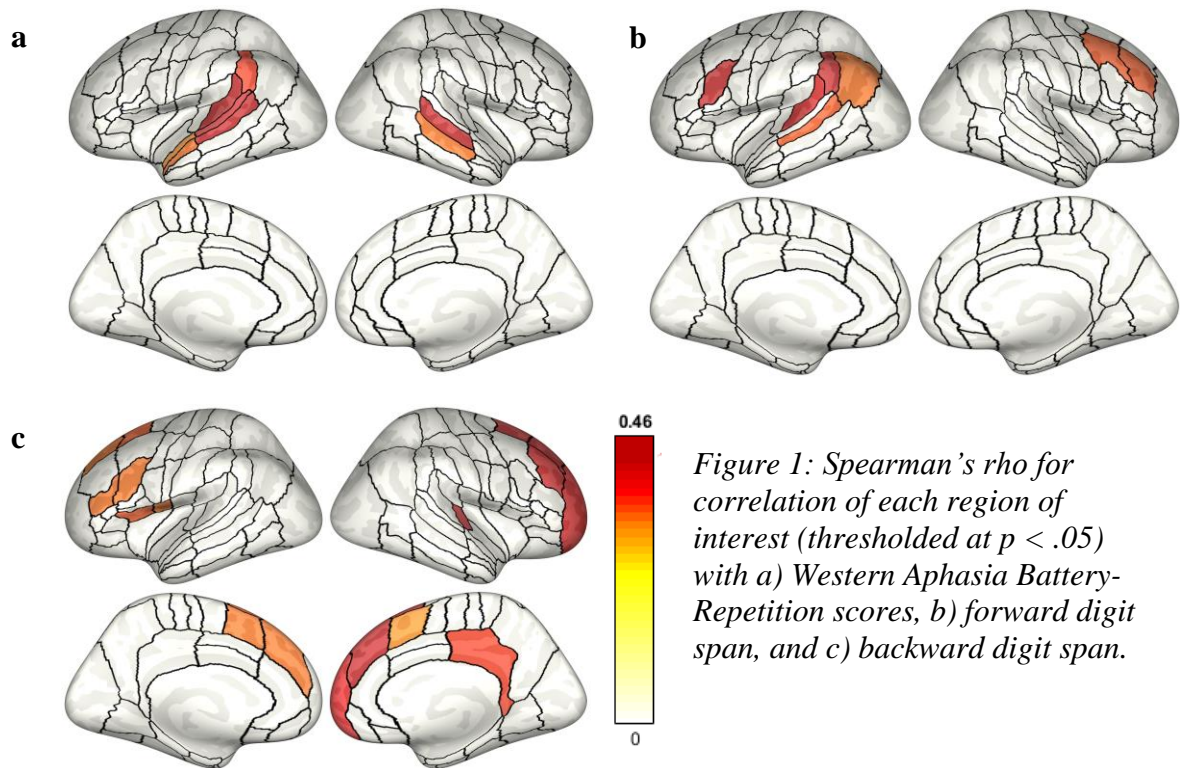
Figure 1: Spearman's rho for correlation of each region of interest (thresholded at p < .05) with a) Western Aphasia Battery-Repetition scores, b) forward digit span, and c) backward digit span.

Discussion: The novel finding of correlations between left pIFS cortical thickness and performance on phonological working memory tasks in patients with PPA supports the hypothesized role of left pIFS as a phonological output buffer in the GODIVA model. We also replicated previous findings of left SMG involvement in repetition tasks (Lukic et al., 2019). Additionally, distinct brain regions were correlated with scores from each of the three working memory tasks. These findings provide insight into the neural mechanisms underlying repetition and inform the development of refined tests for increased specificity in differential diagnosis and clinical management for patients with PPA.

References:

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