EasyChair Preprint

№ 6448

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August 28, 2021

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Background:
In recent years, many studies focused on the mechanisms underlying language rehabilitation after left hemisphere stroke. Some studies suggest that normalization of the language network, is crucial for language recovery, while others suggest that compensatory processes, such as right hemisphere involvement in language processing, support language recovery. Examining changes in brain connectivity during language therapy can shed new light on this question. Furthermore, our second aim was to examine to what extent treatment related changes in brain connectivity are specific to the treated linguistic process (i.e., phonology), or whether they generalize to other neurolinguistics processes (i.e., semantics).

Methods: This is a reanalysis of reported data(Leonard et al., 2015; Leonard, Rochon, & Laird, 2008; Rochon et al., 2010). Four participants with aphasia (PWA) and anomia following left hemisphere stroke and eight healthy controls (HC) participated in the study. Two fMRI scans were administered for all participants with 3.5-month interval on average. In the time between the two fMRI scans, PWA underwent phonological component analysis treatment (PCA). The fMRI scans included phonological and semantic tasks and a perceptual matching control task.
Analysis: Dynamic Causal Modelling (DCM) was used to examine effective connectivity among three right hemisphere regions: dorsal IFG (rdIFG), ventral IFG (rvIFG), and lateral temporal cortex (rLTC). The analysis was conducted separately for the phonological and semantic tasks, and all possible connections were included in the model. We identified connections averaged across the linguistic and perceptual condition in each task (A matrix) and connections that were modulated only by the language (phonological or semantic) task (B matrix). For these connections, we asked which changed from pre- to post-treatment in PWA but not in HC.

Results
1) The averaged connectivity across all conditions (A matrix), changed in three connections from pre- to post treatment only in PWA: bidirectional rvIFG↔rLTC in the phonological task, and self-connection of rLTC in the semantic task, all increasing in resemblance to HC.

Because these conditions reflect common lexical access components, which is typically associated with a bilateral network, the increased resemblance to HC may reflect normalization of connectivity in the intact RH. 2) The modulatory effect of the phonological condition (B matrix) on the connection rLTC → rdIFG was strengthened during treatment only in PWA, unlike HC in whom this effect decreased excitation compared to averaged connectivity, as expected. Because phonological processing is typically associated with the left hemisphere, this change may reflect compensation. No changes were found in the effect of the semantic condition. See figure 1.

Conclusions

Following language treatment, we found changes in the connectivity among RH homologs to language regions in PWA. The results offer that compensatory and normalization processes play a simultaneous role in language recovery, and both underlie the involvement of the RH in the chronic phase of aphasia. Most treatment related changes in the current study were associated with phonological processing, which was the focus of treatment, with indication of changes in connectivity associated with semantic processing. Nevertheless, the small sample size used in the current study limits its generalization.

References

Leonard, C., Laird, L., Burianova, H., Graham, S., Grady, C., Simic, T., & Rochon, E. (2015). Behavioural and neural changes after a “choice” therapy for naming deficits in aphasia: preliminary findings. *Aphasiology*, *29*(4), 506–525. https://doi.org/10.1080/02687038.2014.971099

Leonard, C., Rochon, E., & Laird, L. (2008). Treating naming impairments in aphasia: Findings from a phonological components analysis treatment. *Aphasiology*, *22*(9), 923–947. https://doi.org/10.1080/02687030701831474

Rochon, E., Leonard, C., Burianova, H., Laird, L., Soros, P., Graham, S., & Grady, C. (2010). Neural changes after phonological treatment for anomia: An fMRI study. *Brain and Language*, *114*(3), 164–179. Retrieved from http://www.sciencedirect.com/science/article/B6WC0-509GPW8-1/2/e67b56578aabd7d9bc6678f0aff738aa

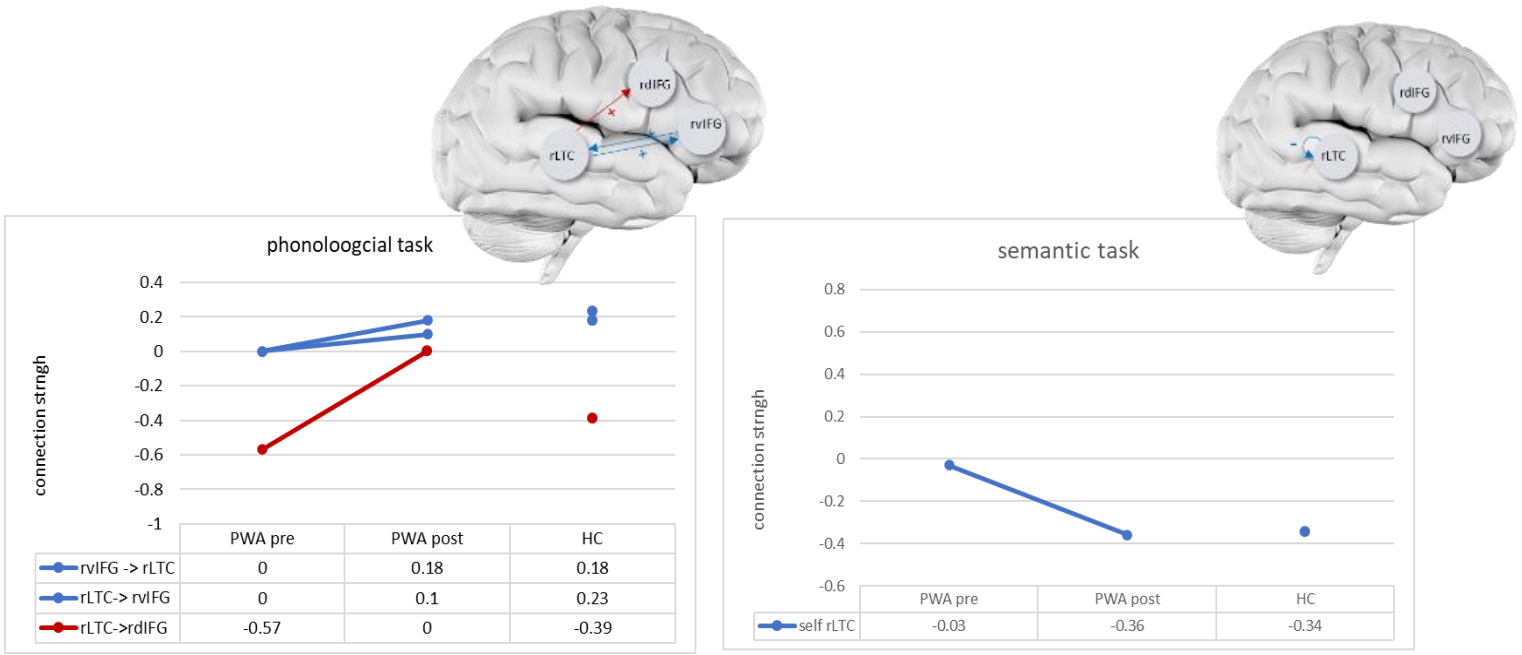

Figure 1. Connections that changed during treatment in patients with aphasia (PWA) and remained stable in healthy controls (HC) in the phonological and semantic tasks. Extrinsic and intrinsic connection strength (in Hz and in unitless log scaling accordingly) are depicted for pre and post treatment for PWA and as the average across time points in HC. Blue indicates the average across conditions (A matrix) and red indicates the modulation of the phonological or semantic tasks (B matrix).