Patterns of brain activation predicting greater language improvement in non-fluent aphasia

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A lot remains unknown about how language is processed in the damaged brain and what the exact relationship between cerebral reorganization and language recovery is (Thompson & den Ouden, 2008). The aim of the current fMRI study was to investigate if specific brain activation patterns associated with language performance are indicative of the degree of overall language improvement. Participants included neurologically healthy individuals (n = 16) and four individuals with chronic aphasia following a left hemisphere CVA . All patients were diagnosed with moderate non-fluent aphasia. The MRI investigation showed that participants with aphasia had lesions in the left fronto-parietal areas. All participants were native speakers of Russian and were premorbidly right-handed. The fMRI investigation was conducted at the middle of a 45-day long intensive rehabilitation course. In the experimental condition a lexical-semantic task was presented to activate the classical language network – three words were visually presented, a verb at the top and two nouns below (for example, *read* – *cat* and *book*). The task was to match a noun to the verb by pressing an appropriate button. All words were matched on critical psycholinguistic parameters. In the control condition, three sequences of symbols were presented: one at the top and two below. Participants had to choose which of the two sequences below was identical to the one on top. Experimental trials were presented in 36 blocks, control trials – in 12 blocks. Each block lasted 18 sec and included three trial of 5.5 sec each with 0.5 sec interstimulus interval. FMRI data analysis was performed in SPM8 ($p < 0.001$, the threshold significance level of clusters $p(FWE) < 0.001$). Language improvement of participants with aphasia was indexed with the Quantitative Assessment of Speech in Aphasia (Tsvetkova et al., 1981) and was measured twice (before and after the rehabilitation course). In healthy participants, the experimental condition contrasted to the baseline, elicited the expected language-associated brain activation in the inferior frontal gyrus, superior and middle temporal areas of the left hemisphere. Two patients with minor improvement showed brain activation patterns in the right temporal area. One of them also demonstrated additional activation in the right inferior and middle frontal gyri. Both participants with significant improvement showed similar to the healthy patterns of activation in the left inferior and middle frontal perilesional areas, left superior and middle temporal gyri. One of them showed additional activations in the right inferior frontal gyrus, right temporal area, precentral gyri and parietal areas bilaterally. The results show that re-recruitment of the left posterior frontal and temporal areas during language rehabilitation is indicative of significant improvement, while recruitment of just the right hemisphere areas associates with less improvement. This finding is in line with previous studies that demonstrated additional left hemisphere activation associated with better language performance in aphasia while additional recruitment of the right hemisphere usually reflected less efficient language processing in the chronic recovery phase (Fridriksson et al., 2009, 2010; Price & Crinion, 2005).