Overt naming fMRI pre- and post-TMS: Two nonfluent aphasia patients, with and without improved naming post-TMS

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Introduction

Brain re-organization in aphasia remains unclear; fMRI studies may provide insight. Chronic nonfluent patients with LH stroke have been observed to have high activation in R perisylvian language homologues during language tasks, reflecting possible maladaptive neural plasticity (Belin et al., 1996; Naeser et al., 2004).

Repetitive transcranial magnetic stimulation (TMS) allows painless, noninvasive stimulation of cortex. Slow (1 Hz) rTMS appears to decrease excitability in the targeted cortical region of interest (ROI) (Chen et al., 1997). We hypothesize that suppression of activity in a targeted RH ROI with 1 Hz rTMS will have an overall modulating effect on elements of the distributed neural network for picture naming, resulting in behavioral improvement. Our TMS results support this hypothesis (Naeser et al., 2005).

We report overt naming fMRI for two nonfluent patients, pre- and post- ten, 20-min, 1 Hz rTMS treatments (90% motor threshold), to suppress the posterior–inferior R pars triangularis. One patient showed good response (P1), with improved picture naming at +2, +6 Mo. post-TMS (out to +43 Mo.); and one patient showed poor response (P2), with no change in picture naming at +2, +6 Mo. post-TMS. Their fMRIs show different patterns of LH activation post-TMS.

Case reports

P1 was an engineer (R-handed) with LMCA stroke at age 49. Structural MRI showed LH lesion in Broca’s area and most of Wernicke’s area and in the lowest premotor and sensorimotor cortex. Lesion was present in parts of supramarginal gyrus.

At 9 years poststroke he was treated with TMS. His language was tested at +2, +6, +16, +43 Mo. post-TMS. His longest phrase length increased from a rating of 3 (pre-TMS), to 5, 5, 5, and 6 words, respectively. His BNT increased from 11 (pre-TMS) to 14, 15, 15, and 15. His auditory comprehension for Commands was largely unchanged, from 12 (pre-TMS), to 15, 15, 15, 15.

fMRI, P1. Pre-TMS, there was high activation in R M1 mouth and R posterior IFG and his score on naming pictures in the scanner was 17/60 (28%). At +3 Mo. post-TMS, fMRI showed less R IFG and R M1 activation, with new activation in L and R BA20, and R BA37, with naming, 25/60 (42%). At +16 Mo. post-TMS (11 year poststroke) naming improved to 58%. Activation was, for the first time, in a small remaining part of L BA45, and L sensorimotor cortex; in addition to increased L SMA activation relative to R SMA.

P2 was a high school teacher (R-handed) with LH stroke at age 56. The lesion was atypical because it extended from L perisylvian to near brain vertex. Structural MRI at 10 months post-onset (MPO) showed lesion in Broca’s area and the lower and mid-to-upper premotor/motor cortex. There was WM lesion deep to L SMA. Lesion was present in most of Wernicke’s area, a small portion of posterior MTG, supramarginal gyrus, and parts of angular gyrus.

Pre-TMS his language was tested three times (12 MPO). His longest phrase length was 1; BNT scores were 1, 3, and 1 (mean = 1.67; SD = 1.15); and Commands scores were 8, 10, and 8 (mean = 8.67; SD = 1.15). At +2 and +6 Mo. post-TMS, his longest phrase length remained at 1 word; BNT score was only 1; commands improved by 2 SD, from a pre-TMS mean of 8.67–11. Complex Ideational Material improved from pre-TMS mean, 2.33 ($\bar{SD} = 0.58$) to 4, at +6 Mo. post-TMS.

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fMRI. P2. Pre-TMS fMRI showed more activation in L SMA than R SMA, and high activation in R M1 and R IFG. At +3 and +6 Mo. post-TMS, this pattern was similar. There was no improvement in naming pictures on the post-TMS fMRIs (scores ranged 1–4). There was new LH activation at +3 Mo. post-TMS in L BA6, L anterior STG, and in L BA38. At +6 Mo. post-TMS there was only activation in L BA6 and no LH activation in language areas.

Of note, a few months after the +3 Mo. post-TMS fMRI, he was given a hand-held augmentative speech device. He was facile with the device and it appears his own efforts at verbalization were reduced (personal observation). The effect of this on his +6 Mo. post-TMS fMRI and language testing is unknown. (Patients were requested not to have new speech therapy intervention during the TMS study.)

Conclusions

P1, good response, showed a general shift to new LH activation and higher L SMA activation than R SMA, at +16 Mo. post-TMS. New LH activation is compatible with some studies where this was associated with language improvement following speech therapy (Cornelissen et al., 2003; Leger et al., 2002; Small, Flores, & Noll, 1998). P2, poor response, showed some new L temporal lobe activation on the +3 Mo. post-TMS fMRI (without improved picture naming), but on the +6 Mo. post-TMS fMRI, this was no longer present.

References


