Examining differences in the localization of language function between various languages using nrTMS and subcortical pathway tractography

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Background
• Anatomy of language function: high individual variability, various languages might have different locations in the brain
• Navigated repetitive transcranial magnetic stimulation (nrTMS): localize individual language functional brain sites

Aim
Our study aims to investigate how nrTMS-based cortical locations of language function and DTI tractographies of language-eloquent subcortical pathways differ between various languages (Slavic and Indo-Germanic languages).

Method
40 patients (2014-2019 cohort): left-sided brain lesion, right-handed (Edinburgh Handedness Inventory), preoperatively mapped using an object naming task in various languages

Magnetic Resonance and Diffusion Tensor Imaging
• T1 + contrast administration
• T2/3D FLAIR
• DTI

Navigated Repetitive Transcranial Magnetic Stimulation
• Object naming task
• Baseline + nrTMS stimulation trials
• 3 stimulations at 46 brain sites inducing language errors

Subcortical Pathway Tractography
• ROIs: nrTMS error-inducing language-positive sites
• Tractography of whole language network and individual language pathways

Data Analysis
• Error rates: number of errors divided by the total number of stimulations at a stimulation site
• Volumetric analysis of subcortical pathways

Figure 1. Methodology Overview.

Results

Figure 2. A) shows significant differences in error rates between Slavic and Indo-Germanic languages. B) shows significant differences in error rates between the languages spoken by bilingual individuals. Red points mark differences that were significant at $\alpha = .05$ while orange points mark differences that were marginally significant at $\alpha = .10$.

Figure 3. Differences in Subcortical Pathway Volumes. No differences in relative pathway volumes between the two languages spoken by a bilingual patient. Language 1 is represented in green while Language 2 is represented in red.

Conclusion
Even though the underlying subcortical structure may be similar across languages, there are significant differences in the pattern of cortical location of language between various languages depending on the semantic processing. This is important for indication but also the resection of language-eloquent brain lesions since the location of language cannot be generalized across languages or individuals.