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Disconnectomic simulation reveals repetition pathways in a case of mixed transcortical aphasia

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Introduction
Mixed transcortical aphasia (MTA) represents an uncommon aphasic syndrome, characterized by severe deficits in both comprehension and production across oral and written linguistic modalities, in contrast with retention of repetition abilities, often manifesting as echolalia. In the present single case study, we report the case of a woman who presented with MTA symptoms after a left hemisphere ischemic stroke involving perisylvian areas, with substantial preservation of reading abilities. The neural underpinning of her residual repetition and reading capacities is explored here employing recently developed lesion-based approaches for white matter disconnections'probabilistic simulation.

Methods
Language abilities were evaluated with the ENPA battery (Capasso & Miceli, 2001) 6-days post-stroke.
We employed two state-of-the-art disconnectomic simulation toolkits called BCB Toolkit (Foulon et al., 2018) and Lesion Quantification Toolkit (Griffis et al., 2021) to reveal which white matter tracts are likely related to the reported pattern of language impairment. The first toolkit calculates the probability with which every tract is affected by the lesion, together with the proportion of lesioned volume of each tract. The second one, instead, calculates the percentage of streamlines that are crossed by the lesion, for each white matter bundle.

Results
Our patient presented with poor comprehension and reduced spontaneous production abilities, while repetition was preserved for words, short sentences, and complex number words up to three digits (e.g., three-hundred-forty-six). Notably, her reading abilities remained intact, in contrast with several previously reported MTA cases. An impairment of verbal and nonverbal short-term memory (verbal span –digit span = 2; spatial span –Corsi block-tapping test = 3) was found.
The results from the two disconnectomic simulation toolkits showed a major disconnection of the left arcuate fasciculus, left inferior fronto-occipital fasciculus, left inferior longitudinal fasciculus, left optic radiation, and anterior commissure. Specifically, regarding the arcuate fasciculus, she presented with disconnected long and posterior branches, while the anterior one was preserved.

Conclusions
Following recent results by Forkel and colleagues (2020), the observed impairments of the patient in the repetition of long sentences and of complex numbers exceeding three digits'might be explained based on the disconnection of the arcuate fasciculus' long and posterior branches, related to impaired short-term memory abilities. Conversely, her preserved ability to repeat and read limited verbal material seems to be supported by the intact anterior branch of the left arcuate fasciculus.
In conclusion, this case report represents the second documented endeavor within the extant literature to provide a comprehensive delineation of white matter tracts'involvement, utilizing state-of-the-art toolkits, in elucidating plausible mechanisms underlying brain disruption in an infrequent aphasia syndrome.

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