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White matter correlates of morphological processing in word reading

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Morphological processing is an essential component in reading, but the white matter underpinnings of this skill are largely unknown. We analyzed the relationship between morphological measures, assessed behaviorally in adult English readers, and microstructural properties of white matter pathways identified using diffusion MRI (dMRI). Morphological processing was assessed using the morpheme interference paradigm (e.g., Crepaldi et al., 2010). For each subject, morphemic cost was calculated as the difference in accuracy for pseudowords constructed from real morphemes, compared with pseudowords containing an invented morpheme. We hypothesized that morphological processing relies primarily on ventral-stream reading pathways, as morphemes provide prominent cues for mapping between print and meaning. Accordingly, we targeted major ventral pathways: inferior fronto-occipital fasciculus (IFOF), inferior longitudinal fasciculus (ILF) and uncinate fasciculus (UF). For comparison, we analyzed two dorsal pathways: the long and anterior segments of the arcuate fasciculus. 49 adults completed dMRI scans at Royal Holloway and a behavioral battery that included the morpheme interference task and measures of phonological and orthographic processing. The tracts of interest were identified bilaterally using deterministic tractography. Fractional anisotropy (FA) and mean diffusivity (MD) profiles were calculated along each pathway, and Spearman's correlations were calculated between these profiles and morphemic costs. Significant negative correlations were found between morphemic cost and FA in the bilateral IFOF. Additionally, significant positive correlations were found between morphemic cost and MD in the left UF and left ILF. Post-hoc analyses revealed that these effects all stemmed from positive associations with radial diffusivity. The correlations remained significant after partialling out nonword repetition scores, suggesting some level of specificity. Morphological processing thus appears to rely on ventral pathways, primarily in the left hemisphere. The results support the contribution of morphological processing to lexical access and comprehension of complex words.
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