Individual differences in corpus callosum structure mediate age-group deficits in auditory spatial processing

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Abstract

Declining auditory spatial processing (spatial localization and selective attention) is hypothesized to contribute to the difficulty older adults have detecting, locating, selecting, and attending to a talker from among others in noisy listening environments. Several cortical structures are known to be involved in auditory spatial processing, often associated with a dorsal “where” pathway. However, little is known regarding the underlying white-matter architecture that facilitates auditory spatial processing or how age-related changes in white-matter structure may affect it. Several animal studies have found that the corpus callosum plays an important role in auditory spatial processing. Studies of humans with callosal agenesis and studies of split-brain patients have found that these individuals exhibit sever deficits in auditory spatial perception. The findings suggest that the corpus callosum is important for auditory spatial processing. The current investigation used diffusion imaging to determine the extent to which age-group differences in the identification of spatially cued speech were accounted for by individual differences in colossal structure while also accounting for individual differences in processing speed and selective attention (measured behaviorally using the Connections Test). Listeners with higher callosal fractional anisotropy (FA) were better able to identify spatially cued speech, even after accounting for whole brain white-matter FA. Listeners with better selective attention were also better able to identify spatially cued speech. Structural equation modeling (SEM) determined that individual differences in callosal FA mediated age-group differences in the spatially-cued speech identification task. Callosal FA and selective attention were found to be unrelated to performance on a non-spatial speech-in-noise identification task (Quick Speech-in-Noise Test), suggesting their relation to spatially-cued speech identification is specific to spatial information processing and spatial attention. Callosal fibers were then segmented into nine different tracts connecting different left-right cortical structures. Follow-up analyses identified the callosal fibers connecting left and right anterior frontal, superior frontal, motor, posterior parietal, and occipital cortices as important for mediating age-group-differences in identifying spatially-cued speech. The results suggest the corpus callosum plays an important role in spatial processing, perhaps by facilitating the cross-hemispheric transmission of information between several cortical areas. The results also reveal a white-matter architecture that underlies auditory spatial processing and provide a cortical mechanism to account for age-related deficits in spatial processing.

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