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The Tuned Cortex: Convergent Expertise-Related Structural and Functional Remodeling across the Adult Lifespan

Erik A. Wing, Jordan A. Chad, Geneva Mariotti, Jennifer D. Ryan, and Asaf Gilboa

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Abstract

Neuroplasticity is a defining property of the brain. Structural and functional brain changes arise soon after learning and are particularly evident following years of practice that underpin expert performance. Much existing evidence comes from work on individual measures of learning rather than interrelated processes. However, the relationship between structural remodeling, functional tuning, and processing domain-specific stimuli is central to how the brain and behavior adapt with experience. Here, we provide a multimodal view of cortical reorganization in a domain for which high-level perception, attention, and memory are shaped through extensive practice: bird identification expertise. In both skilled bird identification experts (n=29; ages 24–75, 15 female) and matched novices (n=29; ages 22–79, 14 female), cortical structure was assessed with diffusion-weighted MRI. Functional and behavioral measures were obtained during a delayed matching task requiring identification of local and nonlocal species. Compared with novices, experts showed lower mean diffusivity in frontoparietal (SFG, IPS) and posterior cortical (AG, precuneus, LOC, fusiform) areas, along with a trend for more gradual increases in age-related MD. This suggests a regionally specific increase in structural complexity and potential attenuation of age-related decline. Across these regions, lower MD predicted higher identification accuracy in experts. Task-related BOLD timecourses revealed that these same frontoparietal regions were selectively engaged when experts judged less familiar nonlocal (vs local) birds, and the magnitude of this nonlocal>local response tracked performance. Together, these results suggest convergent structural remodeling and functional tuning in service of expert performance across the lifespan.

aging cortex expertise fMRI learning neuroplasticity

Keywords

aging, cortex, expertise, fMRI, learning, neuroplasticity

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