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Laminar Architecture Encodes Link between Pruning and Cognitive Decline: a Study of Cortical Thinning

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Cortical thinning is associated with pruning, neuroplasticity, and cognitive decline. While age is a crucial predictor of thinning, it does not account for all its variability. We developed models of cortical thinning based on temporal and spatial variables, including age, cortical type, lobes, brain structures, curvature, and laminar architecture. We utilized MRI scans from 871 participants without neurological history to estimate annual cortical thinning across the lifespan, alongside laminar architecture profiles from the BigBrain dataset. Subsequently, we employed a Gradient Tree Boosting algorithm to predict thinning using three different feature set: temporal, spatial, and temporal-spatial. The temporal model (age as the only variable) achieved an r-squared of 0.79, the spatial model (all variables except age) had a score of 0.58, and the temporal-spatial reached 0.84. Through the use of Shapley additive explanations in the temporal-spatial model, we see the contribution and interactions of each variable to cortical thinning. Age was the feature that most contributed to the cortical thinning, followed by layer I thickness, cortical thickness at 10y.o. and layer IV thickness. Our examination suggests regions that experience more thinning during development tend to undergo less thinning during aging, and this correlation is linked to Layer I thickness.

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