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Increasingly diverse brain dynamics in the developmental arc: using Pareto-optimization to infer a mechanism EVELYN TANG, CHAD GIUSTI, GRAHAM BAUM, SHI GU, ELI POLLOCK, ARI KAHN, DAVID ROALF, TYLER MOORE, KOSHA RUPAREL, RUBEN GUR, RAQUEL GUR, THEODORE SATTERTHWAITE, DANIELLE BASSETT, University of Pennsylvania — Motivated by a recent demonstration that the network architecture of white matter supports emerging control of diverse neural dynamics as children mature into adults, we seek to investigate structural mechanisms that support these changes. Beginning from a network representation of diffusion imaging data, we simulate network evolution with a set of simple growth rules built on principles of network control. Notably, the optimal evolutionary trajectory displays a striking correspondence to the progression of child to adult brain, suggesting that network control is a driver of development. More generally, and in comparison to the complete set of available models, we demonstrate that all brain networks from child to adult are structured in a manner highly optimized for the control of diverse neural dynamics. Within this near-optimality, we observe differences in the predicted control mechanisms of the child and adult brains, suggesting that the white matter architecture in children has a greater potential to increasingly support brain state transitions, potentially underlying cognitive switching.

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