Title: Mapping Brain Activity During Reasoning Behavior Using Individualized Network Atlases

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Abstract:

Most previous human neuroimaging studies use large group averages to identify brain regions that are activated during cognitive tasks. However, results from a group average can wash out important individual differences in activation patterns - especially in highly variable brain regions like the prefrontal cortex. In order to further understand the unique connectivity patterns that support human reasoning behavior in individual participants, we created individualized brain network maps for each of our participants. Twenty-seven healthy young adults underwent functional MRI scanning while they performed reasoning tasks. We constructed individualized network maps for each participant using an iterative reassignment algorithm. Beginning with a standardized network atlas, the algorithm utilized an individual's connectivity patterns to adjust the network membership of each brain region. The personalized atlases were then compared to the existing standard atlas. Our results suggest that overall, subjects had very similar brain network organization to each other. We observed three brain networks that were consistently activated by the reasoning task: Dorsal Attention, Cognitive Control, and Visual. When comparing the standard atlas to the individualized atlases, we found that sensory networks (Visual and Somatomotor) in individuals closely resembled those in the generalized atlas, but that the topography of associative networks (Dorsal/Ventral Attention, Default, & Cognitive Control) varied widely across subjects. Our results suggest that individual differences in associative networks may play an important role in enabling reasoning behavior. Additionally, this method could have potential applications for personalized medical treatment.