Cognitive Science
UC San Diego

Weiqi (Vicky) Zhao's Defense

Characterizing the Neural Basis of Individual Differences in Behaviors Using Large-scale, Population-based Neuroimaging Studies

Tuesday, August 23rd
10am - 12pm
Join through Zoom https://ucsd.zoom.us/j/91283320662
Or in-person
Altman Clinical and Translational Research Institute (ACTRI) 4W-230 (Conference Room)

Abstract

Much of our understanding of the neural basis of behavioral differences is attributable to studies conducted with magnetic resonance imaging (MRI). Despite its critical role in cognitive neuroscience, MRI findings lack the generalizability for translational uses due to the small and homogeneous samples of traditional MRI studies. To improve on the generalizability issue, large-scale, population-based neuroimaging studies are conducted where MRI data are collected in thousands of participants that are systematically sampled to represent the general population. Now, we have a unique opportunity to harness the statistical power afforded by population-based neuroimaging studies to characterize and quantify the behavioral relevance of MRI measures at the population level.

The goal of this work is to take advantage of a population-based neurodevelopmental study, the Adolescent Brain Cognitive Development (ABCD) Study, to shed light on the optimal fMRI design and analysis pipelines for the detection of behaviorally relevant brain signals. In Chapter 2, I challenged the traditional statistical mapping approach of MRI analysis which assumed that the behavioral differences are explained by sparse, localized brain regions. I demonstrated that at a large, population level, the effects of the association between brain activations and behavioral differences are not sparse but distributed across the cortex (Chapter 2). Aggregating the small effect sizes across the whole cortex can greatly increase the magnitude of the behavioral associations detected by fMRI tasks. This finding is consistent with the observation that behavioral differences are associated with individual differences in distributed, functional brain networks whose activities are measured by functional connectivity (FC), the pairwise correlation of activation across brain regions. In Chapter 3, I carried out a systematic investigation on the optimal fMRI paradigms for the detection of behaviorally relevant FC patterns by quantifying the behavioral prediction performance of FC patterns derived from resting-state fMRI and task fMRI. Results showed that behaviorally relevant functional brain signals are better captured by task fMRI paradigms where participants are engaged in cognitive tasks that assess similar mental constructs as the behavior of interest. These results suggest that carefully designed fMRI tasks and multivariate statistical methods that capture the distributed effect sizes of the brain are more useful for the study of brain-behavior relationships at the population level.

Committee members:
Terry Jernigan, Co-Chair, Cognitive Science
Anders Dale, Co-Chair, Neurosciences
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Deanna Greene, Cognitive Science
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