

Project Proposal: Exploring the Causal Relationship Between Autism Spectrum Disorder and IQ Scores

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1 Problem Statement and Motivation

This project will investigate the causal relationship between Autism Spectrum Disorder (ASD) and IQ scores. Given the complex and diverse nature of ASD, the study aims to understand how this neurodevelopmental condition impacts cognitive abilities, as measured by various IQ parameters.

This study is particularly interesting as it dives into the complexity of ASD, a condition with a wide range of manifestations, especially in cognitive abilities. To date, there have been no studies analyzing the causal effect of ASD on cognitive functioning using robust causal methods. Therefore, understanding this relationship can provide valuable insights into the diverse cognitive profiles associated with ASD. By gaining a clearer view of how ASD impacts cognitive functioning, interventions can be better tailored to individual needs.

2 Related Work

- Wolff N, Stroth S, Kamp-Becker I, Roepke S, Roessner V. Autism Spectrum Disorder and IQ - A Complex Interplay. *Front Psychiatry*. 2022 Apr 18;13:856084. doi: 10.3389/fpsy.2022.856084. PMID: 35509885; PMCID: PMC9058071.
- Di Martino A, O'Connor D, Chen B, et al. Enhancing studies of the connectome in autism using the autism brain imaging data exchange II. *Sci Data*. 2017;4:170010. Published 2017 Mar 14. doi:10.1038/sdata.2017.10

3 Dataset

For this project, we will primarily use the ABIDE (Autism Brain Imaging Data Exchange) dataset. This rich dataset includes a variety of relevant variables such as ASD diagnoses, IQ scores (comprising Full-Scale IQ, Verbal IQ, and Performance IQ), alongside demographic information like age and gender, and clinical details pertinent to the study. Moreover, we aim to include another set of covariates of latent representations of MRI images data (extracted using deep learning techniques like CNN or VAE) which would allow for an exploration of the potential neurobiological features that might correlate with cognitive variations in individuals with and without ASD.

4 Methodology, Experiments, and Evaluation

To conduct our experiments, we define the treatment $Z_i \in \{0, 1\}$ as an indicator of ASD (1 corresponding to patient with ASD), X as our covariate matrix, with features including age, sex, handedness, medication use, MRI features, etc., and the outcomes $Y^{(1)}, Y^{(2)}, Y^{(3)}$ as different IQ scores (FIQ, PIQ and VIQ resp.). Our methodology will incorporate Augmented Inverse Probability Weighting (AIPW) with crossfitting for a doubly robust estimation of ASD's causal effect on IQ scores. We will also explore different types of matching (propensity score, 1-to- k , etc.) for balancing ASD and non-ASD groups across covariates to enhance model robustness. To ensure the validity of our causal inference, we will conduct sanity checks for assessing ignorability and perform sensitivity analysis for potential unobserved confounders.

We will evaluate the causal effect using various confidence intervals of our test statistics for $Y^{(1)}, Y^{(2)}$ and $Y^{(3)}$ from a Neymanian perspective.