



A Data-Driven Characterization of Neuropsychiatric Disorders using Measures of Attention, Working Memory, and Response Inhibition

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Motivation and Overview

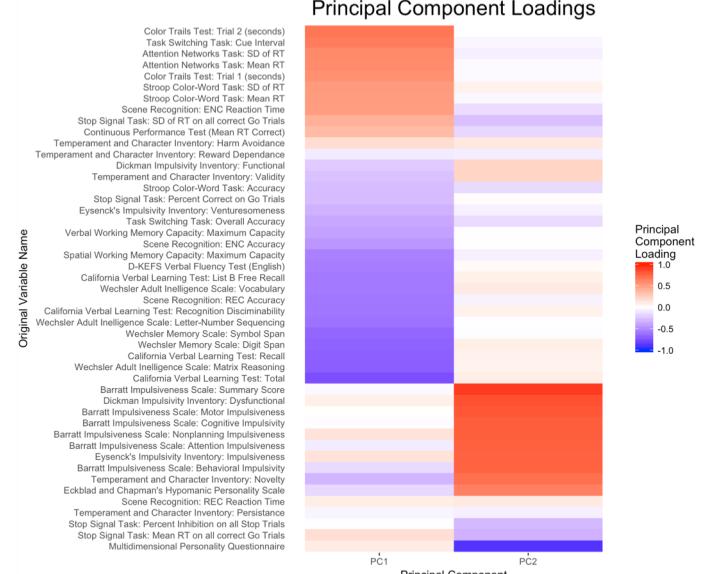
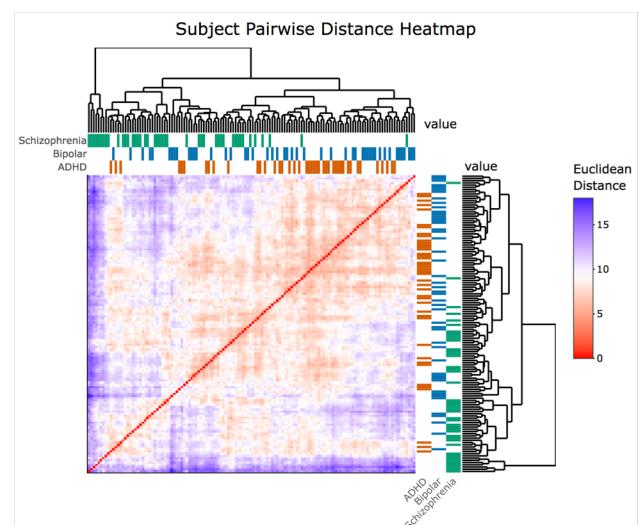
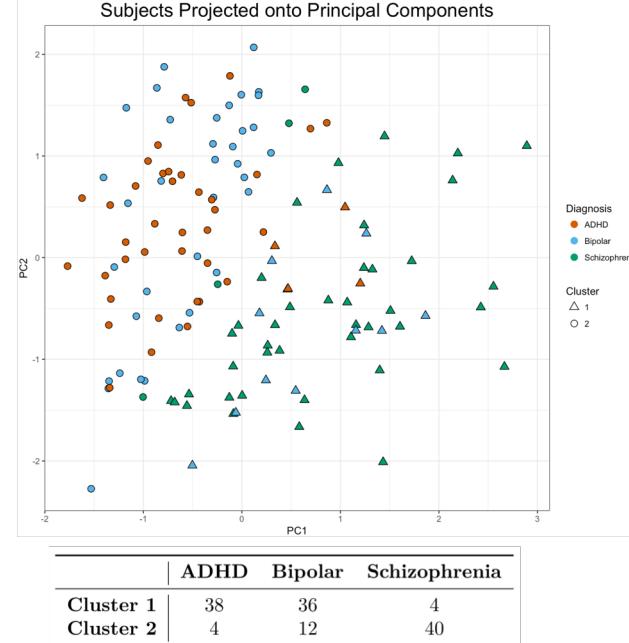
- Psychiatrists have traditionally relied on the *Diagnostic Statistical Manual of Mental Disorders* (DSM-5) to make diagnoses.
- The DSM-5 has been criticized because boundaries between disorders are not as strict as it suggests [1].
- An ongoing challenge in the field is to identify disease biomarkers that correlate with underlying brain dysfunction [2].
- Schizophrenia, bipolar, and ADHD, for example, share core features (impairments in attention, memory, and inhibition) but are distinct categories in the DSM-5 [3].
- We performed *k*-means clustering on a transdiagnostic sample to assess whether individuals with clinical abnormalities in attention, working memory, and response inhibition tend to form coherent disorder subtypes.

Data and Methods

- We used a dataset shared on OpenfMRI, from UCLA's Consortium for Neuropsychiatric Phenomics, with 47 measurements on 134 participants including demographics, traits, and results from neurological/neurocognitive tasks [4].
- All subjects were between 21 and 50 years of age.
- All had a clinical diagnosis of ADHD ($n = 42$), bipolar disorder ($n = 48$), or schizophrenia ($n = 44$).
- We used *k*-means clustering with several values of *k*.
- We determined the optimal number of clusters using the average silhouette width and Calinski-Harabasz [5] statistic. We tested whether a 2-cluster solution was appropriate using the Duda-Hart test.
- We used PCA to visualize and compare our clusters.

Domain	Measure
Demographics & General Health	<ul style="list-style-type: none"> Study-specific demographic form General Health Questionnaire Smoking Status
Traits	<ul style="list-style-type: none"> Barratt Impulsiveness Scale (BIS-11) Dickman Functional and Dysfunctional Impulsivity Scale Millon Clinical Multiaxial Personality Questionnaire (MCQ) Impulsiveness, Venturesomeness and Empathy Scale (IVE) Hypomanic Personality Scale (HPS) Chapman Scales Temperament & Character Inventory (TCI)
Neurocognitive Tasks	<ul style="list-style-type: none"> Task-switching Task Stop Signal Task (SST) Verbal Capacity Task (VCAT) Attention Network Task (ANT) Continuous Performance Go/NoGo (CPG) Stroop Color Word Task (SCWT) Stop Signal Task (SST) Scene Recognition Task
Neuropsychological Assessment	<ul style="list-style-type: none"> California Verbal Learning Test (CVLT-II) WMS-IV Symbol Digit WMS-IV Visual Reproduction WMS-IV Letter Number Sequencing WMS-IV Digit Span WMS-IV Vocabulary WMS-IV Matrix Reasoning Color Trails Test

Clustering and Dimension Reduction Results



Analysis and Discussion

- Both the average silhouette width and Calinski-Harabasz statistic suggested a 2-cluster solution. The Duda-Hart test showed significant clustering tendency ($k \neq 1$).
- Subjects with ADHD and subjects with schizophrenia were well-separated in the 2-cluster solution.
- Subjects with bipolar disorder were not well distinguished from those with schizophrenia or ADHD, even when forcing a $k = 3$ cluster solution.
- Cluster 2 suffered from impairments in attention and memory relative to cluster 1.
- When comparing only those subjects diagnosed with bipolar disorder, those in cluster 1 displayed greater impulsivity, as measured both by trait measures (e.g. the Barratt, Dickman, and Eysenck impulsiveness scales) and cognitive measures (e.g. lower response times and poorer inhibition on the Stop Signal Task).
- Our results support two coherent yet distinct subtypes of individuals with bipolar disorder that are either more like schizophrenia or more like ADHD.
- Future work will explore the stability of the 2-cluster solutions under small perturbations and examine the distribution of features not included in the original analysis across the clusters.

References and Acknowledgements

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