How do data-driven profiles of cognitive & motivational performance relate to neurodevelopmental & anxiety diagnoses?

# Cognitive Control & Reward Delay in youth with Neurodevelopmental & Anxiety Diagnoses

1

## Population & setting

Healthy Brain Network (community sample of children & adolescents)

2

## Measures

3 Executive function (EF) tests from NIH Toolbox

Temporal Discounting (TD) task: now vs later monetary choices

3

## Data sources

local download from HBN portal

- NIH Toolbox Scores
- Temporal Discounting Task Scores
- Clinician diagnosis labels

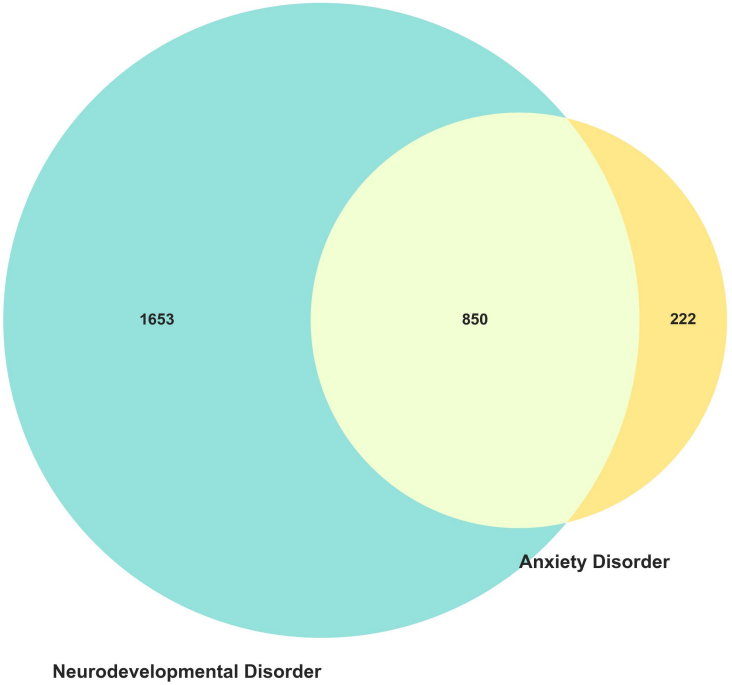
via HTTP

- Public phenotype CSV

# What's confusing about current diagnostic labels?

## Comorbidity

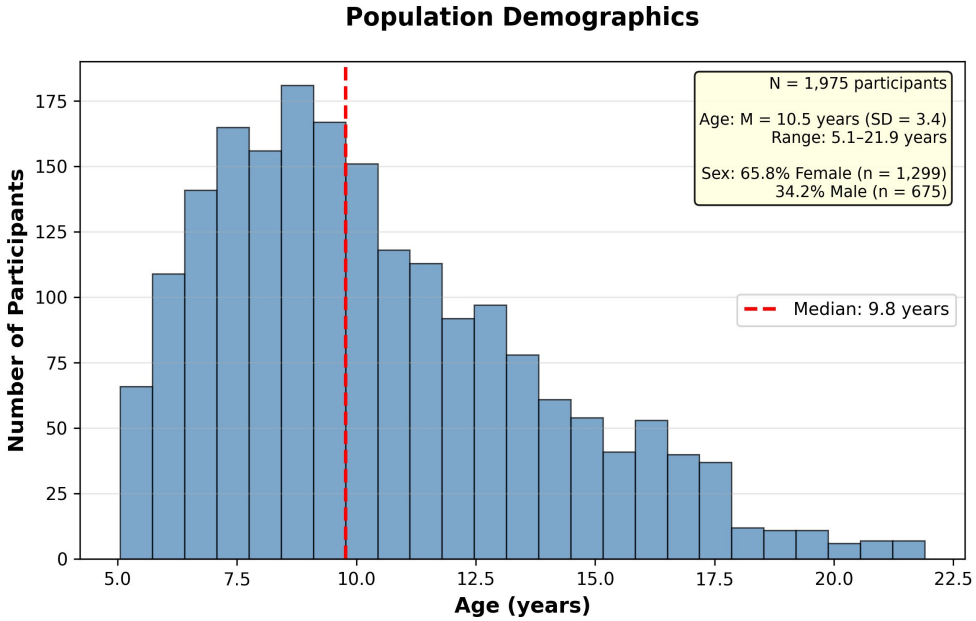
Neurodevelopmental & anxiety disorders show high overlap

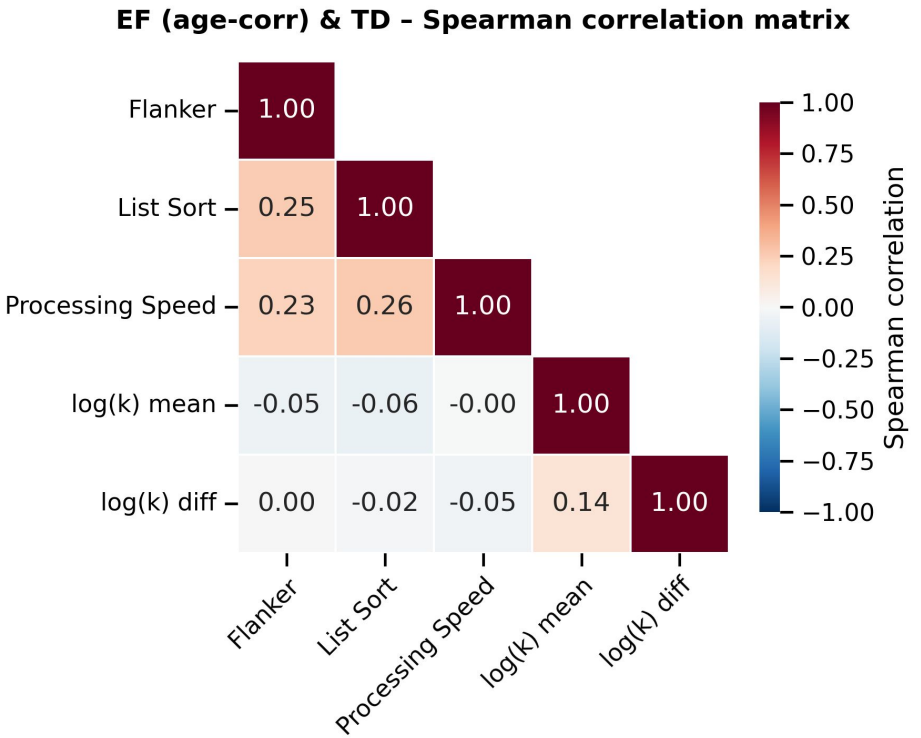


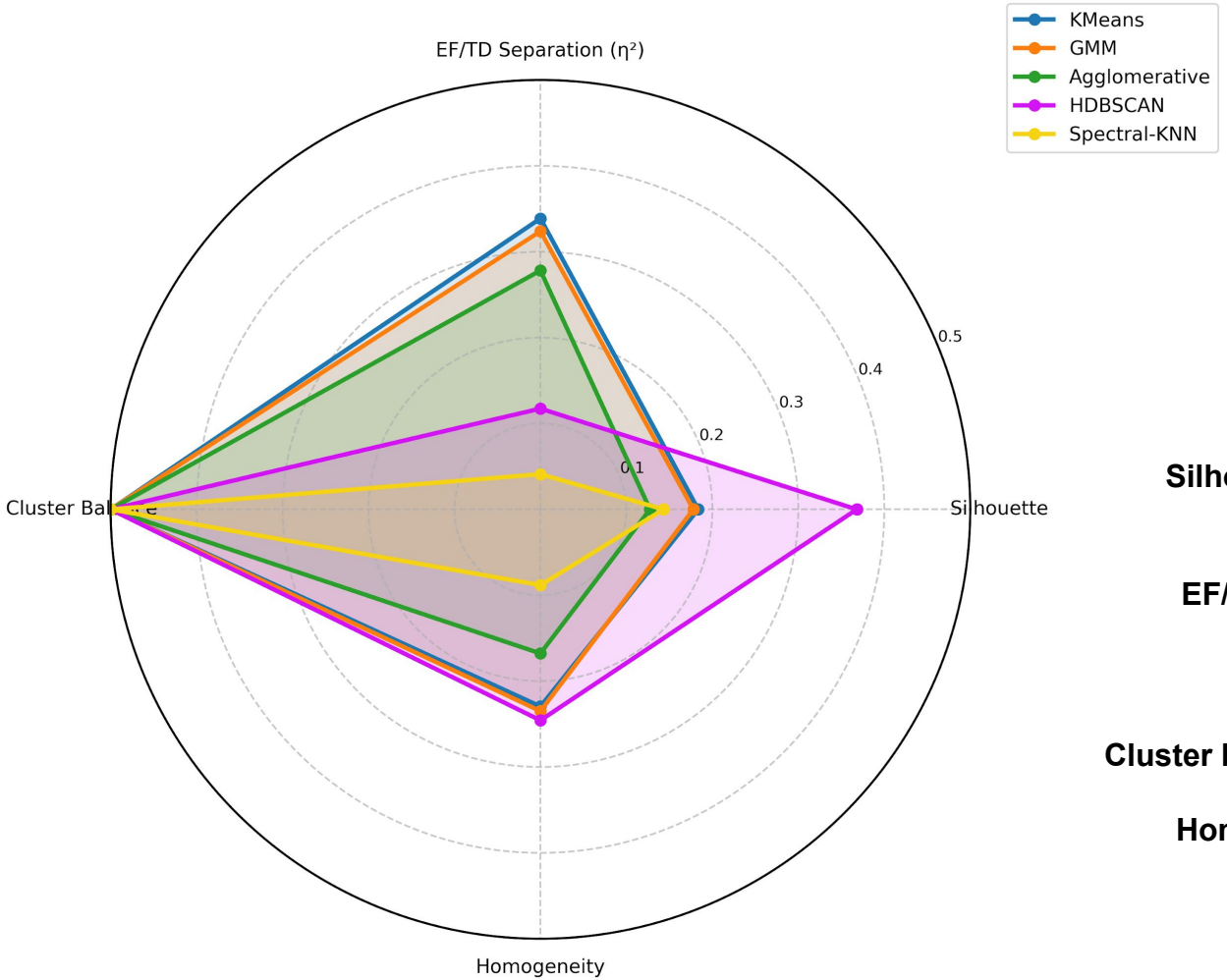

## Heterogeneity

Neurodevelopmental disorders have multiple subtypes

# Sample Characteristics and EF/TD Feature Space






# Choosing a clustering method

## Metrics (higher is better)

**Silhouette**: separation in EF/TD space

**EF/TD η²**: how much EF/TD variance clusters explain

**Cluster balance**: evenness of cluster sizes

**Homogeneity**: within-cluster similarity

# Choosing a clustering method

**Composite score = weighted blend of internal-validity metrics**

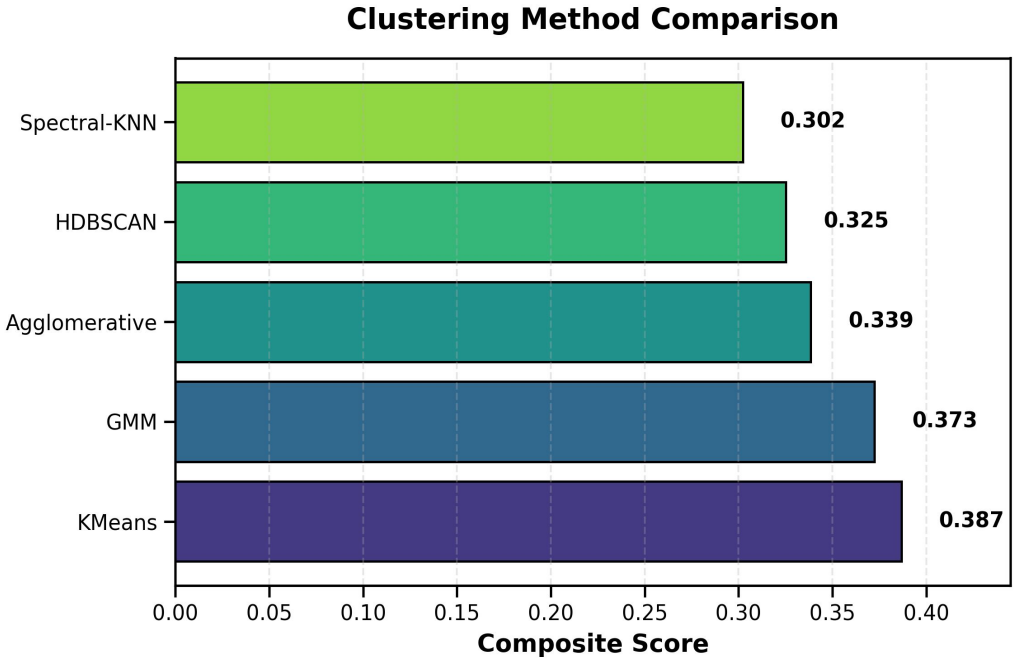
**Separation & stability**
silhouette × coverage (tight, well-separated clusters)

bootstrap stability (labels reproducible across resamples)

**Feature separation (EF/TD)**
how much variance in EF/TD scores is explained by cluster labels ($\eta^2$)

**Demographic confounds**
penalties if age or sex alone can explain the clusters ($\eta^2$ for age, Cramér's V for sex)

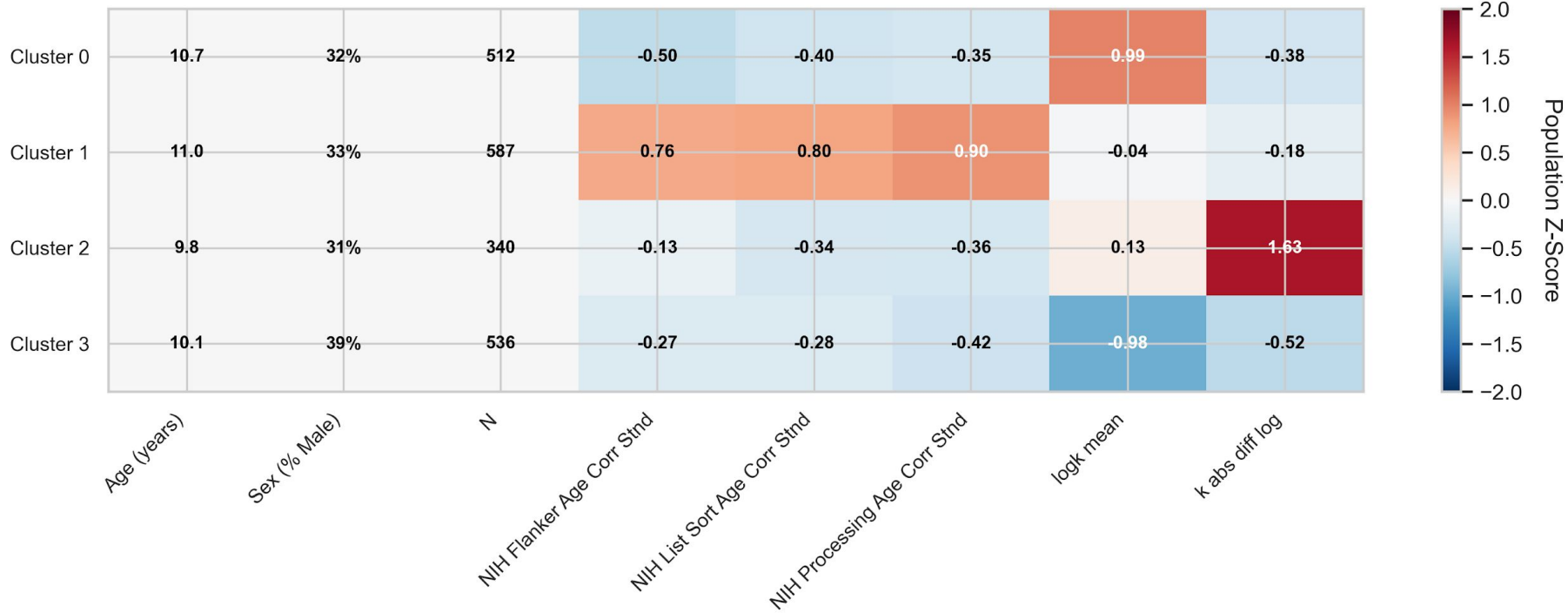
**Cluster shape**
balance of cluster sizes and within-cluster homogeneity



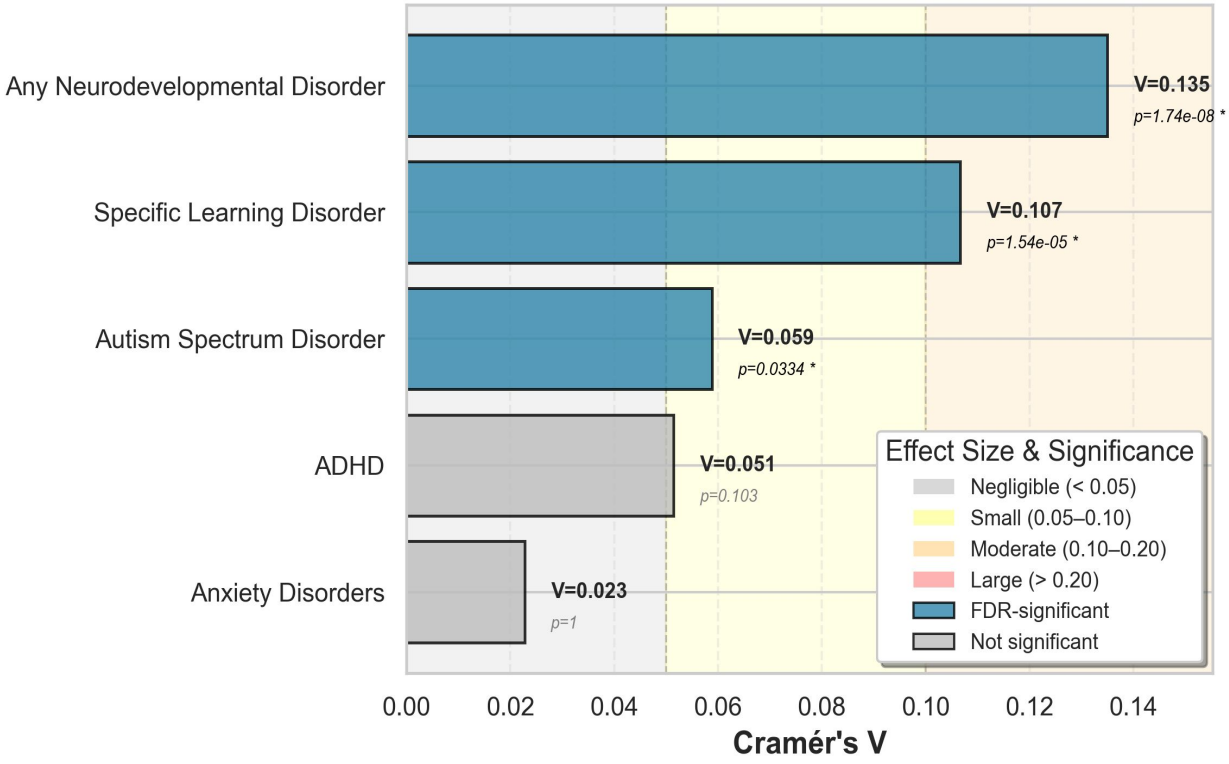
# 4 Clusters in Executive Functioning & Temporal Discounting

1. **High-EF**
2. **Impulsive and EF-low**
3. **EF-low but patient**
4. **EF-low with unstable discounting**

- Age/Sex/N are **direct descriptive numbers** (not standardized values)
- All EF & TD columns are **population-mean** (not cluster-mean) **z-scores**



# How strongly do clusters associate with diagnoses?




**For each diagnosis**:

1. Make **contingency table**: 4 clusters × yes/no diagnosis
2. Run **$\chi^2$ test of independence** on that table
3. Compute **bias-corrected Cramér's V**
    a. a standardized effect size from $\chi^2$
    b. ranges from **0 (no association)** to **1 (perfect association)**
4. Get **p-value** from the $\chi^2$ test and apply **FDR correction**

**Higher V = stronger cluster–diagnosis association**

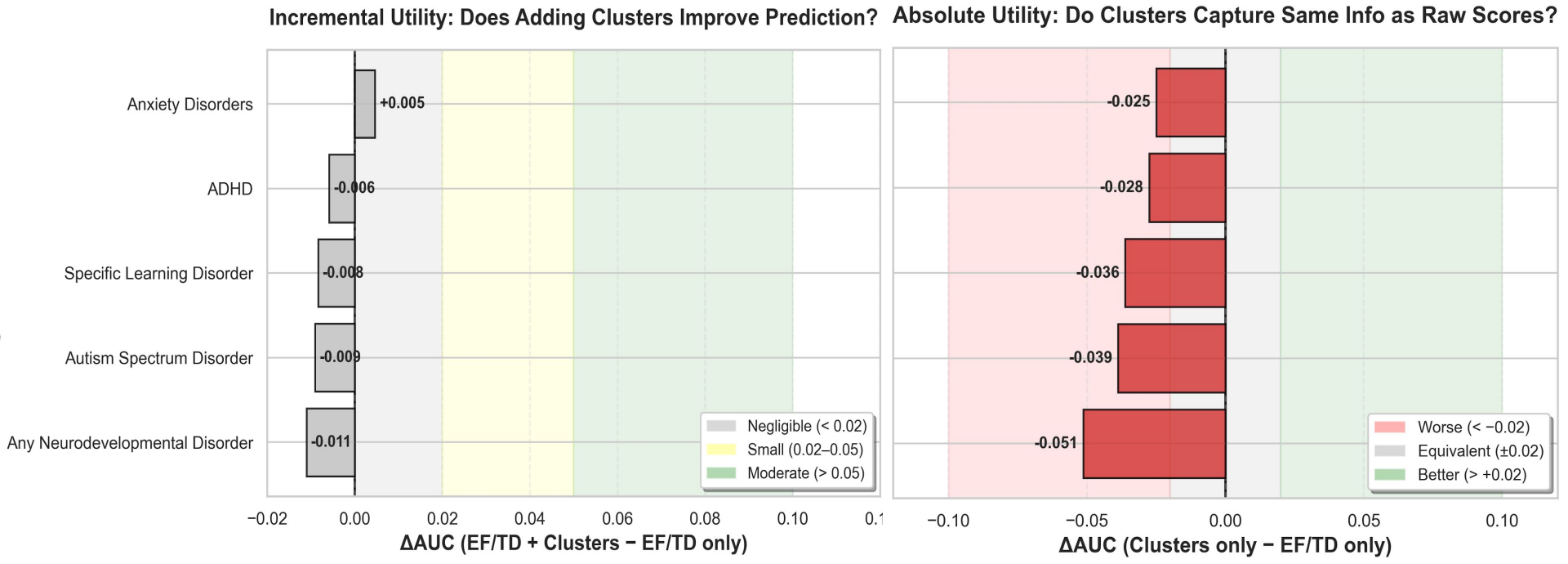
# Do clusters help predict diagnoses beyond EF & TD raw scores?

- Clusters do **not** add predictive power beyond EF/TD scores.
- As standalone predictors, clusters are **slightly weaker summary** of raw EF/TD information.

**For each diagnosis:**

Outcome = yes/no diagnosis.

Models are **logistic regressions** with **cross-validated AUC**.



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# Challenge: interpreting a 'small / null' result

1

## Result

Clusters show only small associations with diagnoses

Adding clusters to raw EF/TD scores does not significantly improve predictive accuracy

Clusters-only models show slightly lower predictive accuracy than raw EF/TD scores

2

## Interpretation

clusters are descriptive & interpretive tools for EF/TD heterogeneity

not replacements for diagnoses

3

## Future Directions

link clusters to dimensional symptoms & functioning

add richer measures (emotion, variability, longitudinal data) to test prognostic value