BWAS replicability with multivariate structural connectome based brain models for small sample sizes using HCP1200

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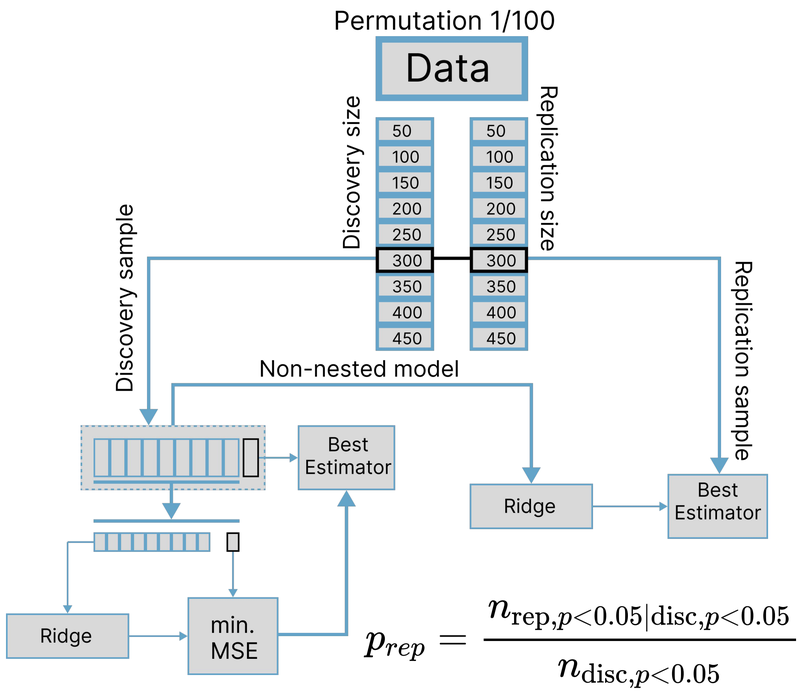
Challenges in replicability: BWAS often face significant challenges in replicability, requiring large sample sizes for reliable results (Marek et. al., 2022).
Advantages of multivariate techniques: Unlike traditional univariate approaches, multivariate learning techniques can achieve higher effect sizes, potentially allowing for replicable results with small-to-moderate samples (Spisak et. al., 2023).
Focus on diffusion-weighted imaging: Despite its importance in assessing microstructural integrity, replicability of multivariate BWAS based DWI measures like structural connectivity, FA, MD, RD and AD is not well understood.
Empirical evaluation: We conducted a large-scale empirical analysis to evaluate the replicability of DWI-based multivariate models, providing insights into sample size requirements and effect sizes across different phenotypes.

Machine learning pipeline



$$p_{rep} = \frac{n_{\text{rep},p<0.05|\text{disc},p<0.05}}{n_{\text{disc},p<0.05}}$$

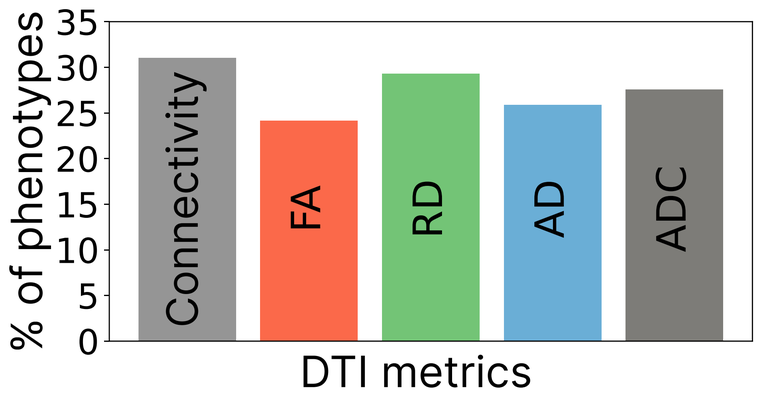
Predictive effect sizes: DWI-based predictive models can explain between **4-10%** of effect sizes for behavioural phenotypes.

Sample sizes versus effect sizes: For phenotypes necessitating large sample sizes (state-like), replicable effect sizes tend to be smaller. Here, approach data acquisition cautiously, as increasing the amount of data may not readily enhance effect sizes.

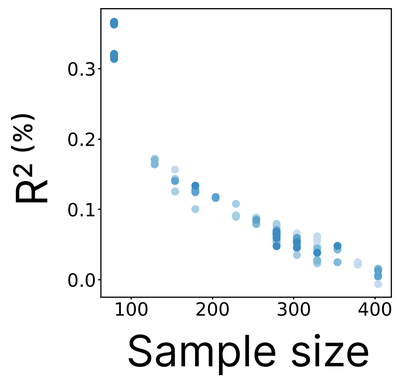
$$n \propto \frac{1}{R^2}$$

Trait versus state phenotypes: Trait-like phenotypes that are embedded in long-term structural changes (>60% traits are replicable) need more attention.

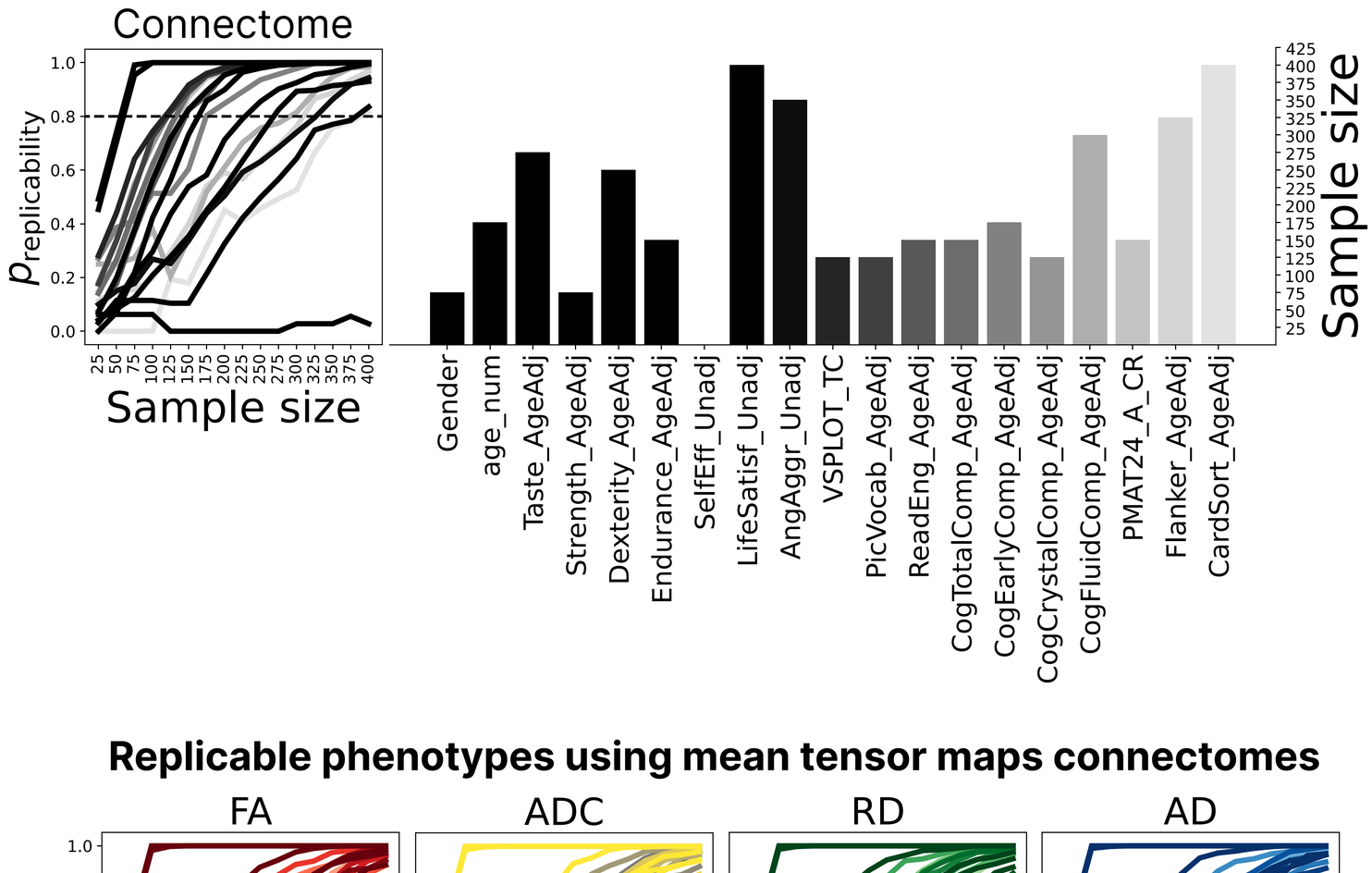
Replicable phenotypes with N<500



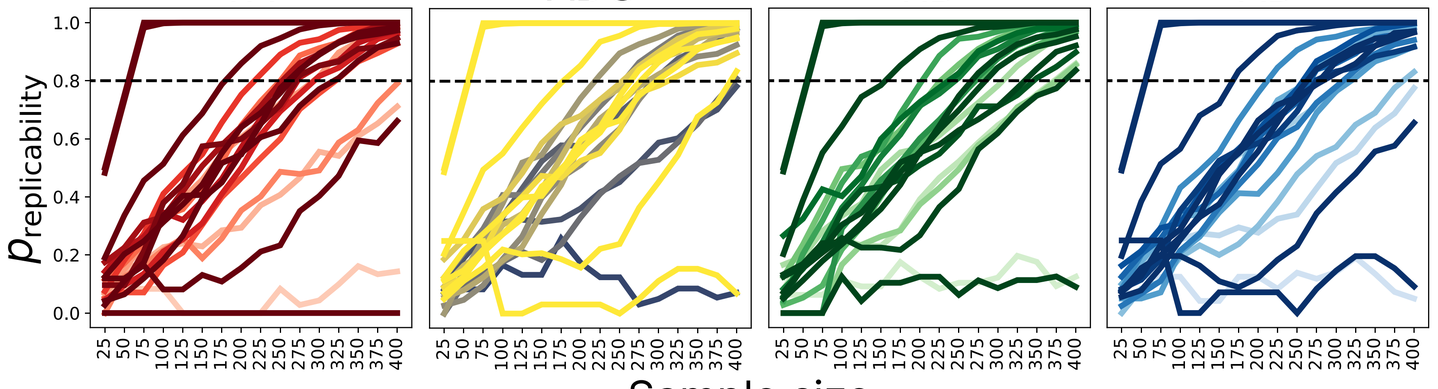
Effect size versus replicability



Replicable phenotypes using DTI connectome



Replicable phenotypes using mean tensor maps connectomes



Marek, Scott, et al. "Reproducible brain-wide association studies require thousands of individuals." Nature 603.7902 (2022): 654-660.
Spisak, T., Bingel, U. and Wager, T.D., 2023. Multivariate BWAS can be replicable with moderate sample sizes. Nature, 615(7951), pp.E4-E7.

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