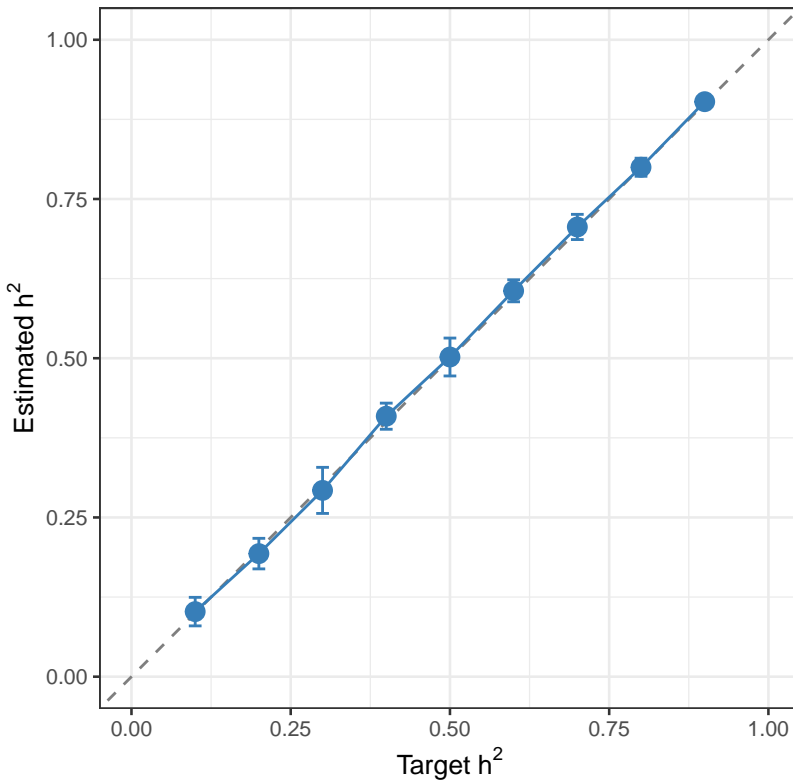**Supplementary Figure S2: Advanced Phenotype Simulation Validation**
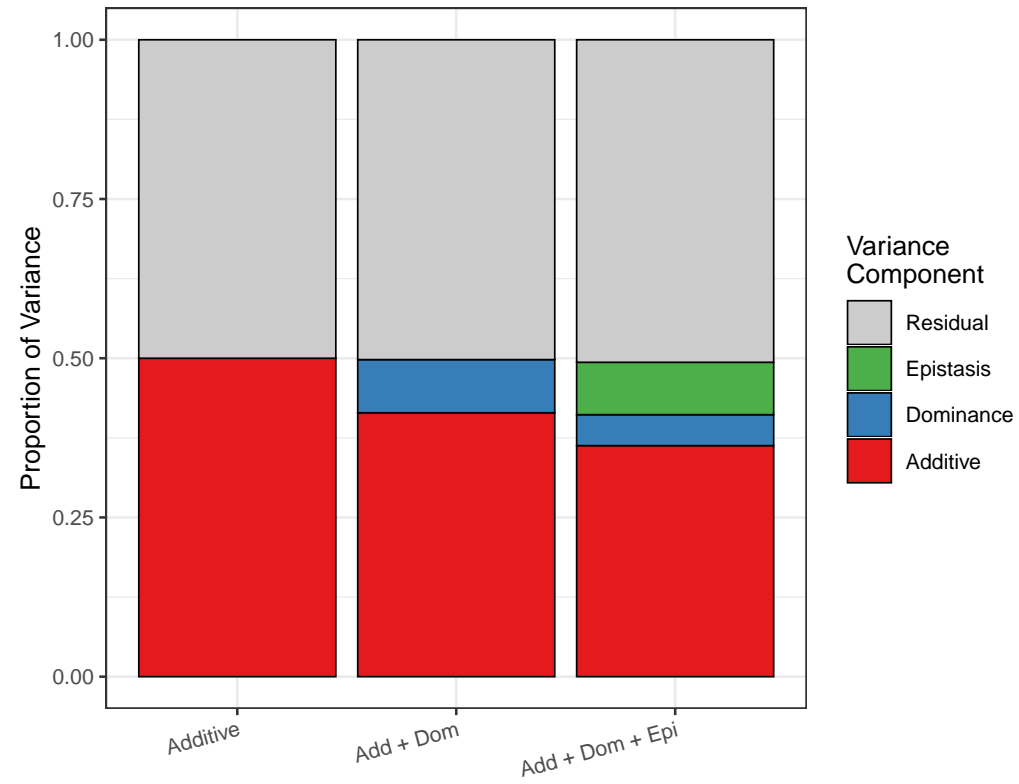
Simulated population: 500 samples, 1000 SNPs, 20 QTNs
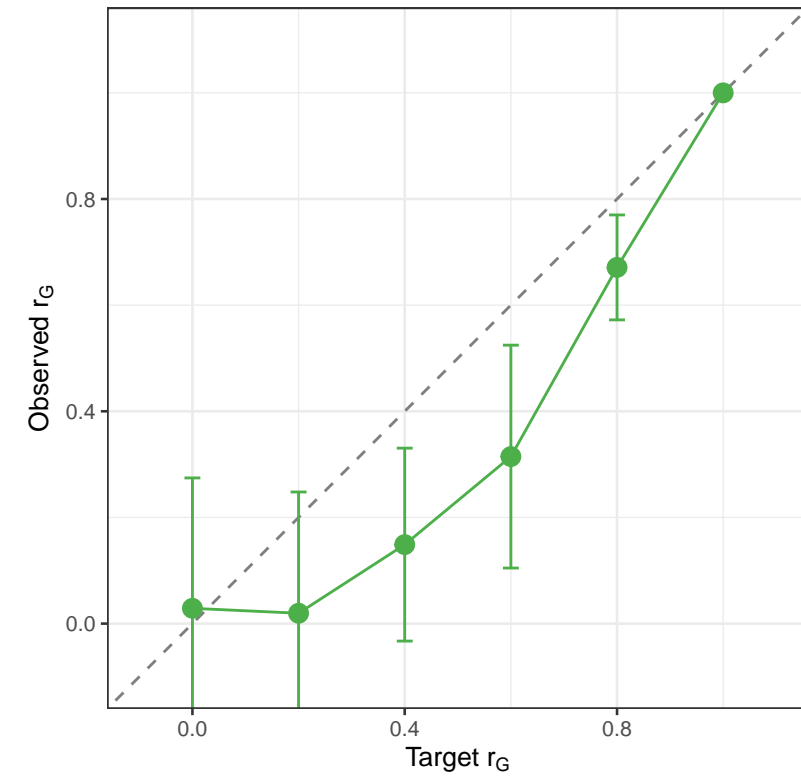
A. Heritability Accuracy
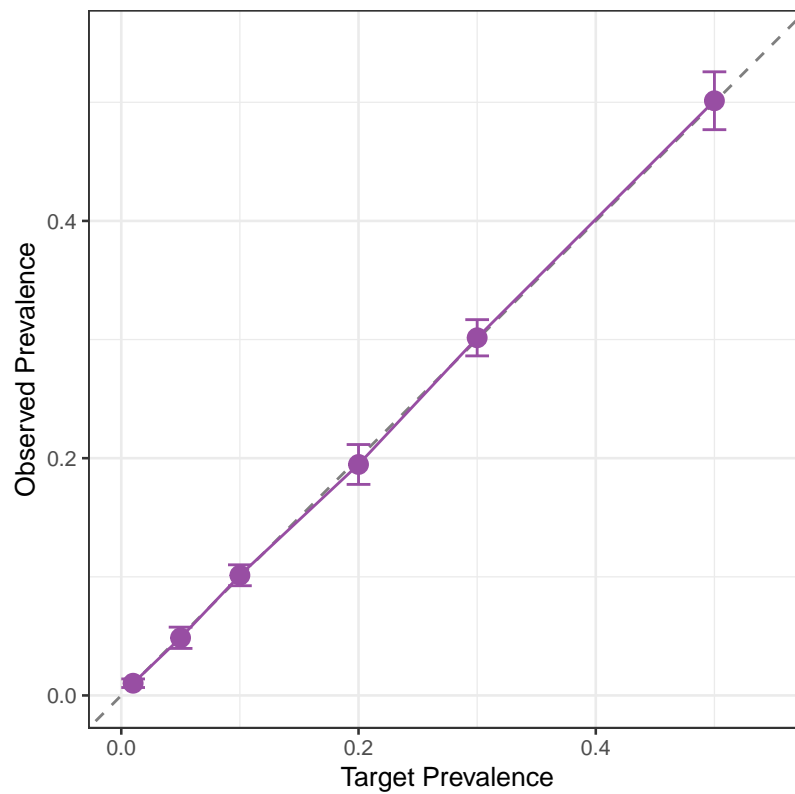
B. Genetic Architecture Models

C. Multi−Trait Genetic Correlation

D. Binary Trait (Liability Threshold)

E. Gene−Environment Interaction