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Bivariate estimation of vertical transmission and genetic nurture using polygenic scores

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ABSTRACT:

As offspring resemble their parents for both genetic and non-genetic reasons, family-based approaches have struggled to disentangle variance due to shared genetic factors from variance due to shared environmental factors. Several recent studies^{1,2} have sought to differentiate these overlapping causes by examining the extent to which parents' non-transmitted alleles influence their offspring's phenotype; however, no studies to date have been able to estimate the effect of a parental trait on a different offspring trait without suffering significant bias, thus greatly limiting the number of questions that can be asked using these approaches. Here, we introduce a series of bivariate causal models that address this gap by using parental polygenic scores (PGS's) to obtain within- and cross-trait estimates of both vertical transmission and genetic nurture. Unlike past approaches, these models are able to (1) account for direct genetic effects, pleiotropy between PGS's, and within- and cross-trait assortative mating at both equilibrium and disequilibrium; (2) provide unbiased estimates of vertical transmission and genetic nurture, even when a trait's PGS explains only a small portion of total heritability; (3) be implemented without full trio data; and (4) be easily altered or extended to best fit the traits and data being used. As such, these models provide a novel approach for understanding how parental genes and traits influence their offspring.

¹Kong A, Thorleifsson G, ..., Gudbjartsson DF (2018). The nature of nurture: Effects of parental genotypes. *Science*, 359(6374),424-428.

²Balbona JV, Kim Y, Keller MC (2021). Estimation of parental effects using polygenic scores. *Behavior Genetics*.

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