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Nurture net of nature: Re-evaluating the role of shared environments in academic achievement and verbal intelligence

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ABSTRACT

Prominent authors in the behavioral genetics tradition have long argued that shared environments do not meaningfully shape intelligence and academic achievement. However, we argue that these conclusions are erroneous due to large violations of the additivity assumption underlying behavioral genetics methods – that sources of genetic and shared and nonshared environmental variance are independent and non-interactive. This is compounded in some cases by the theoretical equation of the effective and objective environments, where the former is defined by whether siblings are made more or less similar, and the latter by whether siblings are equally subject to the environmental characteristic in question. Using monozygotic twin fixed effects models, which compare outcomes among genetically identical pairs, we show that many characteristics of objectively shared environments significantly moderate the effects of nonshared environments on adolescent academic achievement and verbal intelligence, violating the additivity assumption of behavioral genetic methods. Importantly, these effects would be categorized as nonshared environmental influences in standard twin models despite their roots in shared environments. These findings should encourage caution among those who claim that the frequently trivial variance attributed to shared environments in behavioral genetic models means that families, schools, and neighborhoods do not meaningfully influence these outcomes.

1. Introduction

Three decades of behavioral genetics research largely concludes that shared environments play only a minor role in shaping individual outcomes, and that the appearance of this influence is attributable to gene–environment correlations. For instance, in *The Nurture Assumption*, Harris (1998) argues that children are principally shaped by their parents through genetic pathways, and that socialization primarily takes place at the peer level. Similarly, in *The Limits of Family Influence*, Rowe (1995) argues that socialization research is founded on unsupported assumptions concerning the separability and relative importance of genetics and home environments. By ignoring the dual genetic and environment inheritance processes that potentially shape children's lives, these authors argue that sociologists and other social scientists have confounded environments with genetics, and have accordingly overstated the role of family, school, and neighborhood influence.

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These conclusions are broadly influential in psychology (e.g., Plomin et al., 2001a,b; Plomin and Daniels, 1987) and the popular discourse. Although these claims are not identical, these findings are often interpreted to mean that family life negligibly influences children's prospects (Harris, 1998; Rowe, 1995).

These are valid concerns – because genetics are rarely accounted for in sociological research on parental, neighborhood, and school influences on children, if genetic factors are related to shared environments and the outcomes, genetic confounding is a possibility. Because sociological and other social science research frequently concludes that these social environments are major determinants of educational prospects in early childhood (Alexander et al., 2007; Fryer and Levitt, 2006; KewalRamani et al., 2007), adolescence (Camara and Schmidt, 1999; Hedges and Nowell, 1999; Kobrin et al., 2007) and beyond (Elman and O'Rand, 2004; Roscigno and Ainsworth-Darnell, 1999), it is important for sociological researchers to critically examine this literature to evaluate its conclusions.

We argue that shared and nonshared environments exert important influences on the academic achievement and verbal intelligence of adolescents in the United States. The common conclusion that shared environments are inconsequential for these outcomes, we argue, is attributable to two key assumptions of classical behavioral genetic models and related writings which have not received wide attention outside of that field. First, standard behavioral genetic models assume that genetic, shared environmental, and nonshared environmental influences are additive and separable – the *additivity assumption*.[1] Second, these models assume that objectively shared environments operate by making siblings more phenotypically similar – the *homogenizing assumption*. In other words, the homogenizing assumption occurs when shared environmental variance estimates (which measure non-genetic sources of sibling resemblance) are interpreted to reflect the variance explained by the objectively shared environment (factors to which siblings are commonly exposed; Goldsmith, 1993; Rutter et al., 1999; Turkheimer and Waldron, 2000).[2] Furthermore, ongoing research on gene–environment interactions emphasizes that genetic and environmental influences are frequently non-additive, and research on socialization and the sociology of education emphasizes that objectively shared and nonshared environments are deeply intertwined in both their distribution and their effects. These non-additive processes can both have the result that objectively shared environments serve to differentiate, not homogenize, siblings. Because shared environmental components of behavioral genetic models reflect non-genetic sources of sibling homogeneity, this suggests that negligible estimates of effectively shared environmental influence may be misleading when they are interpreted to indicate that objectively shared environments are inconsequential.

We support these arguments using a regression model capable of estimating environmental effects net of genetic ones – a monozygotic twin fixed effects model. We use this model and data from the National Longitudinal Study of Adolescent Health (Add Health) to demonstrate: (a) the substantive importance of twin differences in behaviors and attitudes for academic achievement net of genetic influence, and (b) the interactive influence of a wide variety of home environmental characteristics with these nonshared environments. We conclude that both components are important determinants of academic achievement and verbal intelligence.

2. Background

2.1. "The nature of nurture"

The claim that shared environments are inconsequential (e.g., Harris, 1998; Rowe, 1995) for most child outcomes suggests that apparent shared environmental effects are in fact due to gene–environment correlations (rGE) whereby individuals with certain genes are more likely to find themselves in certain environments – in other words, rGE is "the nature of nurture" (Plomin et al., 2013:108). For instance, suppose parents who encourage children's studying have higher genetic aptitudes for academic achievement which their children have partially inherited. These children may earn better grades on average due to their advantageous genetic characteristics whether or not their parents encourage their study habits. In this way, the appearance of an environmental effect may be created when in fact a genetic effect is at work.

2.1.1. Behavioral genetics studies of intelligence

The common view that rGE biases sociological studies of environmental influences is clearly reflected in the contrast between behavioral genetic and sociological studies of intelligence and academic achievement. In contrast to the literature on the sociology of education, behavioral genetic research consistently finds that shared environments are responsible for the little of the overall variation in IQ. For instance, Nielsen (2006) finds little shared environmental influence on adolescent verbal IQ using the Add Health dataset, as well as large genetic and nonshared environmental influences. Scarr and Weinberg (1978), using measures of the shared environment in a sample of 16–22 year-old adopted and biological children, similarly find negligible evidence for shared environmental effects on IQ. Many other behavioral genetic investigations of this matter have concluded similarly (Brody, 1992; Hunt, 1997). McGue (1997) writes that, insofar as there is behavioral genetic differences in opinion on this matter, these are differences of degree (Daniels et al., 1997; Feldman et al., 2000). However, in recent

[1] Although behavioral genetics research is frequently concerned with identifying non-additive genetic effects, such as dominance and epistasis, this is not our intended meaning in this case.

[2] Because we wish to address the frequent (but not universal – see Plomin et al., 2013 for a more consistently careful interpretation) conflation of the effective and objective environment, we will not always use the term 'shared environment' in the manner in which behavioral geneticists typically do. See below for a full discussion of this issue.