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The Nature-Nurture Debate and Public Policy

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Abstract

The contentious nature-nurture debate in developmental psychology is poised to reach a rapprochement with contemporary concepts of gene-environment interaction, transaction, and fit. Discoveries over the past decade have revealed how neither genes nor the environment offers a sufficient window into human development. Rather, the most important discoveries have come from unearthing the manner in which the environment alters gene expression (and how genes impose limits on environmental effects), how biology and the environment influence each other across time, and how maximizing gene-environment fit leads to optimal outcomes for children. The manner in which these factors operate in tandem should direct future scholarship, practice, and public policy.

Perhaps the most important, and certainly the most contentious, debate in the history of developmental psychology has concerned the fundamental question of the role of genetic and biological factors versus environmental and learning factors in a child's development. This debate is rooted in philosophical arguments about the nature of the human species as a *tabula rasa* (Locke, 1690/1913) to be shaped by experience versus a "noble savage" to be reined in by environmental constraints on a biological destiny (Hobbes, 1651/1969). Much of the modern study of individual differences in behavioral development through longitudinal inquiry in the 1950s and 1960s inexplicably ignored the role of innate factors but led to unprecedented publicly funded programs (e.g., Head Start) to enrich the early environments of economically disadvantaged children in a War on Poverty (Zigler & Muenchow, 1992). This work had dual premises that disparities across groups were largely a result of environmental disadvantage and that environmental enrichments could repair this inequity.

The naive hope that early environments could be easily manipulated to alter long-term outcomes inspired a backlash of behavior-genetic studies in the 1980s and 1990s that championed the high percent of variance in behavior that is accounted for by genes. The legacy of this backlash is the argument that public and private resources (e.g., the best schools and highest incomes) should be administered according to selection of those with the highest (presumably, genetically based) potential to achieve, rather than to compensate for biological or environmental disadvantage (Herrnstein & Murray, 1994). The scholarly anchor for the policy conclusion was exemplified in essays by Scarr (1992), Lytton (1990), and Harris (1995, 1998) which claimed that the environment accounts for very little influence on human behavior. After 50 years of study, it seemed that little had been learned.

Fortunately, the turn of the 21st century has brought ground-breaking findings that should bring this debate to a rapprochement and new level of sophistication. As highlighted by the National Academy Panel on early childhood development (National Research Council, 2000), these findings suggest a remarkably intimate relation between genes and the environment that is played out in interaction effects, transaction effects, mediational effects, and even evolutionary

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effects. This commentary will review this progress, forecast the next decades of inquiry, and suggest that these new concepts should direct public policy toward children.

Apportioning the Variance in Human Behavior

One of the problems with the gene-environment debate has been that scholars have employed different ways of aggregating measures of behavior in order to estimate gene and environment effects. By doing so, they have asked different questions, but the debate has failed to capture these nuances. Consider Scarr's (1992) assertion that more than one-half of the variance in aggressive behavior is accounted for by genes, and contrast that conclusion with empirical evidence that measures of individual differences in children's aggression are only modestly correlated across home and school settings (*r*'s of about 0.2; Hope, Bierman, & Conduct Problems Prevention Research Group, 1998), across different peer targets (*r*'s of 0.1; Hubbard, Dodge, Cillessen, Coie, & Schwartz, 2001), across types of settings such as play versus classrooms (*r*'s of 0.3; Dodge, Coie, & Brakke, 1982), and across time (*r*'s of 0.5; Coie & Dodge, 1983). Shouldn't these low cross-setting correlations indicate the strong influence of the environment on behavior? Scarr's conclusion was based on the premise that cross-setting and cross-time differences reflect "error variance" that should be resolved by first aggregating measures across source, setting, and time before a test of genetic versus early family environment is conducted. The implication of this aggregation is that, according to the traditional behavior-genetic view, the fundamental gene-environment test concerns the relative proportion of variance accounted for by genes versus early family environment on life-enduring behavior scores that disregard effects of setting, peer target, time, and transient environmental influences. All of the latter effects are assumed to be error variance. In such a test, genes are indeed shown to exert an important impact.

These assumptions inherent in the behavior-genetic test are simply not consistent with a contemporary view of how the environment exerts an impact on behavior. Virtually no environmental theory posits that early family interaction causes effects on aggressive dispositions that will endure forever, no matter what later environmental or maturational influences occur. Rather, the fundamental nature of environmental theory is that social influences alter behavior patterns only as long as those social influences are still present. When the social influences change, the behavior will change (after a delay, in order for the organism to recalibrate the contingencies of the environment). Social experiments of an A–B-A–B design are premised on the *transient* nature of environmental impacts. Such a premise does not diminish the importance of the environment; in contrast, it heightens the continuing importance of the environment across the life span.

Consider as a thought experiment a behavior-genetic study in which monozygotic and dizygotic twins of many different ages are sampled from multiple cultures (including the United States, where handgun homicide rates are a thousand times higher than in some European countries, as well as European and Far Eastern countries) and from multiple time points in history (including contemporary times as well as times before guns were invented). The behavior-genetic test partitions variance into three components: genetic, non-shared family environment (i.e., the differences between persons within the same family), and shared family environment (i.e., differences across families). If the outcome variable is handgun homicide, then no doubt the effect of shared family environment would be over 90%, because gun laws, the invention and availability of handguns, and social constraints on access to guns exert a large impact on handgun homicide that is shared by members of the same family but varies across secular time and culture.

Why does this obvious effect of the environment not bring down the size of the genetic effect in actual empirical studies? Every behavior-genetic study "controls" for environmental

variation that is due to secular time and culture (and a host of other environmental factors) by restricting the sample to a single culture or a single point in history. Furthermore, the outcome variable is rarely a score with such strong ecological validity as handgun homicide. Instead, the outcome variables are ironically so context-calibrated that they virtually eliminate context effects (e.g., a parent's rating of a child's level of aggression).

Several conclusions can be drawn from this debate. First, the gene-environment test depends on whether we are interested in understanding specific behavioral events (e.g., Johnny hitting Daryl on the playground, or Judy shooting Delilah at a party) or immutable personality propensities (e.g., aggressiveness or extraversion). By studying discrete acts or behavior scores that are so dependent on context (e.g., a law prohibiting handgun ownership), we will privilege the effect of the environment. By dismissing transient environmental variation as error variance, we will privilege the effect of genes.

Second, the magnitude of the effect of genes or the environment on individual differences will vary greatly as a function of the composition of the sample being studied, a point well illustrated by the empirical analyses of Stoolmiller (1999). If the sample includes only a narrow range of environmental differences, such as, say, a sample of Scandinavians (which constitute the majority of studies in behavior genetics because of the ease of tracking children across time in this society that keeps splendid permanent records of children's where-abouts), then the estimate of genetic effects will be relatively large. In contrast, one could constitute a sample that maximizes environmental differences to yield a relatively large environmental effect. The proportion of variance accounted for by genes is a description of the sample being studied, with relatively little generalization beyond that sample.

So what is the appropriate sample for these studies? Perhaps we could contemplate the world's entire population. But the population is a moving target. The third assertion being made here is that the human species has evolved across generations to maximize biological potential (i.e., the gene pool), environmental affordances (e.g., gains in nutrition and shelter), and the biological-environmental fit for survival. The result may be that the human species as a species has become more influenced by the environment than ever before and than other species (e.g., human infants today are born more dependent on the mother for survival than any other species), but that because of improvements in, and narrowing of, the minimal environmental standard (which generally holds outside of third-world countries), individual differences in behavior reflect genes to a greater extent than previously. The search for absolute answers to the question of how much behavior is accounted for by genes versus the environment is a futile exercise.

Gene-Environment Interaction Effects

Scarr (1992) asserted yet another of the important insights in this debate when she argued that the environment exerts its effect only at the most extreme end of environmental deprivation (e.g., physical abuse). Her intent was to point out the minimal role of the environment, but this assertion grants an exception to the dominance of the gene and illustrates one kind of gene-environment interaction, namely, that genes might have a larger or smaller effect at different points in the environmental continuum. And so, a body of recent studies has revealed that the environment might well exert a stronger effect on poor children than on children in the middle class (National Research Council, 2000).

This discovery is one example of the broader gene-environment interaction effect. Although it was posited decades ago (e.g., Mischel, 1973), recent discoveries have revealed the enormous power of this effect in describing behavior. Among the most remarkable of these findings are those by the team of Caspi and Moffitt. Following children from the Dunedin Study, they discovered that genetic vulnerability (i.e., an inherited MAOA deficiency) for conduct disorder

is expressed only in the context of the experience of physical abuse (Caspi et al., 2002). Likewise, the impact of the experience of physical abuse on later conduct disorder occurs only among those children who are at genetic risk for this disorder.

Jaffee et al. (in press) recently applied similar concepts in the E-Risk Study of 1,116 twin pairs in Great Britain. They used zygosity status (monzygotic versus dizygotic) and the conduct disorder status of one's twin to grade the genetic risk level of a child, along with evaluations of a history of physical maltreatment, to determine that the effect of physical maltreatment on risk for conduct problems is strongest among those at high genetic risk. The experience of maltreatment was associated with an increase of 2% in the probability of a conduct disorder diagnosis among children at low genetic risk for conduct disorder but an increase of 24% among children at high genetic risk.

Dodge et al. (2003) demonstrated a similar effect in a different context in a sample of 585 boys and girls followed prospectively from preschool through middle school. They examined the effect of the environmental experience of being chronically rejected by one's peer group during early elementary school on growth in aggressive behavior problems by the beginning of middle school. Peer rejection is a major social stressor experienced by 10 to 15% of the school population. They found that this experience was associated with growth in aggressive behavior only among the subgroup of children who had in early life displayed difficult temperamental behavior patterns. Children without that (presumably biologically mediated) propensity did not react to the stressor of social rejection in an aggressive manner. Again, this interaction effect suggests that environmental effects occur within specific biological contexts and that genetic effects depend on environmental circumstances. These demonstrations of true gene-environment interaction effects render the debate about the relative importance of genes versus the environment moot: both factors are undeniably crucial in understanding how behavior unfolds across development.

The Dynamic Relation Between Biology and the Environment

Another major discovery is the understanding of how biological status and the environment are not static entities unrelated to each other but, rather, operate in dynamic tandem across development (Dodge, 1990). Two concepts are worth highlighting.

First, one of the great insights of developmental psychology is that the environment acts in response to a child's biological affordance (National Research Council, 2000). A young child who displays an aggressive disposition will likely be met with a different environmental response than a child with a calm disposition. In healthy environments, the societal response has evolved to compensate for a child's vulnerabilities through extra support, scaffolding, and protection. Thus, vulnerable children may receive extra attention and nurturance. Often, however, the social response may well be to act in a way that mediates the very problematic outcome for which the child is vulnerable. A child with a prickly temperament may incite parents to react with physical abuse or peers to react with social rejection. These environmental experiences, in turn, exacerbate the child's behavioral difficulties and potentiate problem outcomes (Dodge & Pettit, 2003). Some behavior geneticists have used such findings to conclude that the environment is incidental in the developmental path of a genetically vulnerable child, whose destiny is inevitable. This conclusion makes no more sense than concluding that the environmental occurrence of nicotine ingestion through cigarette smoking is incidental to the development of lung cancer in an individual who is genetically primed to like and become addicted to cigarettes. The environment is responsive to one's biological dispositions and may well potentiate morbid outcomes.

Second, not only is the environment responsive to biological dispositions, but biological dispositions evolve in response to environmental inputs. De Bellis (2001) has used MRI

technology to demonstrate that young children's brain volume and structure are altered as a result of maltreatment. Pollak, Klorman, Thatcher, and Cicchetti (2001) have used priming paradigms and electrophysiological recording to demonstrate that children who have been physically abused become perceptually and psychophysiologically ready to attend to hostile facial displays. This acquired biological disposition mimics the genetically based neurological vulnerability displayed by some children to act impulsively and to display attention deficits, and it may well exacerbate behavioral problems. In this case, the psychophysiological reaction to the environmental experience of physical abuse may potentiate the effect of abuse on long-term outcomes.

Thus, the environment and one's biologically based dispositional tendencies may dance with each other across development to lead, in some cases, to compensate for each other's vulnerabilities, and, in other cases, to potentiate each other's effects.

The Gene-Environment Fit

The gene-environment story gets considerably more complicated when we consider the possibility that the human species has biologically evolved to be especially responsive to differences in the environment that one experiences. Belsky, Steinberg, and Draper (1991) have posited the notion that children are born with the capability to alter their biological development by reading the type of nurturant environment that they experience in early life. If the environment is threatening, nonsupportive, and signaling an early demise, then the child may accelerate biological maturation, including puberty, in order to pass along one's genes to the next generation before one's demise. In contrast, if the environment is safe, nurturant, and signaling a long life, then biological maturation may be slowed in favor of higher-quality outcomes and better choices in mating partners for procreation. Evidence has accumulated that is consistent with, but hardly conclusive of, this perspective (Ellis et al., 2003).

Most importantly, this research has led to the concept of the gene-environment fit, the notion that some children may flourish under one set of environmental conditions but flounder under another set, whereas other children may flounder under the first set while flourishing under the second set. Consider the temperamentally exuberant child who has creative ideas but difficulty holding them back from expression. This child might well flounder in a school environment that requires conformity to a predetermined set of rules; the same child could flourish if exposed to challenging tasks and left alone to explore. Bates, Pettit, Dodge, and Ridge (1998) found that children with difficult temperaments responded to lax parenting with growth in aggressive behavior problems but responded to structured parenting with acceptable behavioral outcomes. These findings suggest that parenting intervention programs should not be directed in an identical manner toward all families but should, instead, be targeted toward specific kinds of families based on fit.

Similar principles apply to children's learning styles. Levine (2002) has found that children with learning disabilities can achieve extraordinary outcomes that one might not expect based solely on a genetically driven assessment of intelligence. These children, however, demonstrate differential responsiveness to various educational interventions as a function of child-specific learning styles. Not all interventions will be equally effective with all children. The task for practitioners is to assess each child's profile of abilities and learning styles and then match interventions to each child's profile.

Transforming Research, Practice, and Policy

The discoveries of the past decade have important implications for research, practice, and public policy over the next decade. First, researchers should turn their attention to identifying and understanding the particular ways in which genes and environments interact and transact

in particular domains. The nature-nurture debate has been transformed by the concepts described by the National Research Council in its seminal volume, *Neurons to Neighborhoods.* The search for the gene-environment fit is on.

Second, in order to identify strengths and deficits in behavior or learning, practitioners must assess not only an individual child but also the environment in order to identify the child-environment fit that is optimal for development. Psychological assessments must become environmental assessments.

Finally, public policy must shift away from its current main-effects dual foci on early selection of the best and brightest for privileged status and environmental enrichment for all disadvantaged children. Instead, public policy must begin to focus on matching children with the environments in which they will flourish. Education policy must allow for more individualization in curriculum planning. Early childhood care policy must be tailored toward different kinds of family circumstances. Mental health policy must encourage greater matching of interventions with child characteristics. Health policy, too, must match children with diets and exercise regimens that will optimize healthy outcomes for all children.

Although these reforms will make the world a more complicated place, they will maximize human potential. This legacy is indebted to the contributions of developmental psychology.

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