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Biopsychosocial Models and the Study of Family Processes and Child Adjustment

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In their review, Horwitz and Neiderhiser (2011) provided a thorough discussion of the most recent behavior genetics research that addresses the issue of whether, and under what conditions, genetic factors and family processes are jointly implicated in child behavioral outcomes. The goal of examining the potential gene–environment interplay (GE) on family relationship factors known to be integral to child adaptive functioning is laudable and timely. As Horwitz and Neiderhiser noted, the “independent” effects of genes and environment have been examined in considerable prior research. In addition, and perhaps more importantly, most recent models of genetic influences on both parenting and child behavioral outcomes have discarded any notion that such influences are ever independent of the environment (Meaney, 2010). Family researchers are also beginning to appreciate the converse: any examination of the family’s influence on child functioning must, of necessity, acknowledge that such effects occur in the context of a host of biological processes, whether measured or not (cf., Booth, McHale, & Lansdale, 2011). Thus, behavior genetics research must be evaluated in a light of a broader biopsychosocial framework that acknowledges the complex feedback processes that occur across development (Michel & Moore, 1995).

The work reviewed in the Horwitz and Neiderhiser article, although broad and inclusive, leads to several general conclusions regarding the interplay between genetic factors and family environmental experiences. Genetic factors, operationalized by the authors in terms of “heritable” traits that are observable in either parents or children of varying degrees of biological relatedness, work in concert with parenting behavior to create multiple pathways to child adjustment. Sometimes, these factors are correlated and thus create opportunities for transactional child–environmental influences. Other times, the environment moderates a genetic pathway, again indexed by some trait that is observed in either the parents or the child, to produce different outcomes. And, perhaps most importantly, environmental factors may not be reliably predictive of specific outcomes, as they seem to have differential effects on the behavioral phenotype of a particular inherited trait depending on both the specific dimension of parenting observed and the particular outcomes of interest.

Such findings are of use to researchers studying child and family processes for a variety of reasons, some of which the authors of the review articulated. Studies of GE processes illuminate the shortcomings of direct effects models from a scientific perspective and offer guidance as to points of entry for prevention and intervention in children and families at risk for poor outcomes. But, the usual caveats to the conclusions drawn by such a review are in order. First, behavior genetics research may provide inferences about general principles that govern GE interplay, but it is largely silent as to the actual mechanism of transmission. That is, these studies tell us merely that GE processes are at work in some specified developmental pathway, not, contrary to what the authors sometimes implied, how these essentially biological factors actually lead to a specific behavioral outcome such as child adjustment. Second, behavior genetics research focuses on observed traits, and provides no indication of which genes may be involved in producing which behavioral outcomes. So, although behavior genetics studies can point us in the direction of promising moderators and

reveal whether and under what conditions a behavioral phenotype might be expressed, they cannot explain the pathway from gene action to outcome. This is a critical omission because, as recent molecular genetics research makes clear, the nature of GE depends in a non-trivial way on a host of intervening processes occurring across multiple biological and behavioral levels of an organism's functioning across time (Johnston & Edwards, 2002). Finally, behavior genetics research typically focuses on environmental factors that have previously been studied as main effect predictors of outcomes, like parental warmth and control in early childhood. This narrow and somewhat static interpretation of "E" doesn't itself preclude the possibility that other aspects of the child's environmental experience are operating on the gene's action, as they clearly are, but it tends to reduce GE to a single event and it obscures potent biological and behavioral factors that are likely important as well. Indeed, as Shanahan and Hofer (2005) noted, the E in GE might best be conceptualized as "exposure," a term that highlights the range of processes that may alter the pathway initiated by the gene's cellular action at biological and behavioral levels across development.

Thus, although Horwitz and Neiderhiser provided behavioral scientists with a good first step toward greater understanding of the role of genetics in the complex trajectories that characterize family influences on development, their review also raised a number of issues that are clearly in need of further elaboration. In this commentary, and against the backdrop of a biopsychosocial perspective, I articulate four such issues that are challenging our field, both conceptually and empirically, and that must be confronted in any analysis of GE effects on children's adjustment. These issues include greater specification at the levels of theory, mechanism, phenotype, and development.

Implications for Theory and Model Building

One critical issue raised by Horwitz and Neiderhiser's review is whether and how emerging knowledge of GE processes should alter existing theoretical models of family and child functioning. Behavior genetic research has clearly stimulated growing appreciation for the role of genetic processes in development generally and human behavioral development in particular. And this appreciation has already led many developmentalists to reconfigure their models of development to incorporate both genetic and other biological processes as factors in the emergence of complex behavior (Sameroff, 2010; Shonkoff, 2010). Much of this theory building has also been informed by existing conceptual and empirical work in the discipline of developmental psychobiology, an approach that is interdisciplinary and integrative, combining perspectives from evolutionary and developmental biology and physiology with subdisciplines of psychology to address questions about behavior and its development in humans and non-human animals (Michel & Moore, 1995). And it is this perspective that has had a major influence on subsequent empirical investigations of GE interplay and family processes (cf., Propper et al., 2008).

Psychobiological approaches to the study of early behavioral development remind us that a range of biological mechanisms is implicated in functioning at all levels of analysis. Gottlieb's depiction of *probabilistic epigenesis* (cf., Gottlieb, 1991, 2007) exemplifies the approach; it describes the changes that occur across developmental time in genetic, neural, behavioral, and environmental levels of analysis, and importantly, depicts the bidirectional effects across time from one level to another. Gottlieb's model has stimulated both conceptual and empirical work aimed at providing greater specificity with regard to how the broad model may be instantiated to explain human developmental phenomena. Some of this work has attempted to "unpack" the action within and across levels to describe, for example, how gene action at the level of cellular activity occurs and influences numerous types of neural processes, some of which may ultimately be involved in producing complex behavior (Johnston & Edwards, 2002) of the sort that Horwitz and Neiderhiser refer to as child

adjustment outcomes. Recent empirical work has also adopted Gottlieb's approach and begun to measure transactions across two or more of these levels, for example, from the gene (through molecular genetic analyses that specify candidate genes) to specific physiological processes (like parasympathetic regulation of cardiac output under stress), and importantly, how these relations may be moderated by dimensions of the environment such as parenting across time (cf., Propper et al., 2008). Regardless of the focus of the research or the levels described or assessed, the underlying assumption in this work is the same: Genes initiate developmental pathways that are receptive to influences that occur from the cellular to the social contextual level and all are candidates for GE interplay.

The theoretical and empirical approaches that have roots in psychobiology, and have been adapted to more general models of biopsychosocial functioning (cf., Calkins, 2011), make clear that family researchers cannot ignore that a host of dynamic intervening processes lay between the gene and the behavioral phenomenon of interest, whether that phenomenon is parenting, family functioning, or child adjustment outcomes. It is not necessary that these intervening processes, or even the genes themselves, be measured. It is necessary that theoretical formulations that focus on family processes embed these processes in a context that extends from behavior to genetic, neural, and physiological activity that occurs "under the skin." It is also necessary, in light of the extant research findings, to abandon direct effects models of family influence. Co-action, transaction, and interaction characterize development in a biologically informed model of child functioning (Sameroff, 2010)

Identifying Mechanisms of Transmission

As our understanding of the role of these genetic and biological processes has grown, a shift in focus has occurred in our attempt to understand how specific behavioral developments emerge and influence children's outcomes. Researchers have come to view development as a dynamic process involving transactions between the child and his or her environment that affect children's development, and the behavior of those who comprise their environment, at multiple biological and behavioral levels (e.g., Blair, 2002; Calkins, 2011; Wachs, 1999). Analysis across levels of functioning provides us with insight into the more proximal processes that affect, for example, both caregiver behavior and child functioning.

It is imperative, though, that research that identifies GE interplay specifies the actual process through which these effects occur. Observations that a statistically significant interaction occurs between, say, the putatively inherited trait "negative emotionality" and the environmental variable "parental warmth" to predict fewer child conduct problems, tell us very little about how this outcome is actually achieved. What does parental warmth actually do to alter the hypothesized pathway from negative emotionality to conduct problems? Is parental warmth affecting biological processes, behavioral processes, or both? What is the specific behavior, process, or proximal mechanism (Carter & Fleming, 1995) that increases or decreases the likelihood that a child will engage in the behaviors that are symptomatic of a conduct problem? Not one of these questions is answered in the typical behavior genetics analysis. Without addressing the sorts of questions that shift the focus from the observation that moderation occurs to identifying the actual mechanism that mediates the outcomes in the presence of moderation, we know very little about developmental process. Next steps in family research that adopt a biopsychosocial perspective must address this challenge.

Defining and Refining the Phenotype

One important reason that GE interplay is a valuable empirical focus is that such inquiries force scientists to better articulate the behavioral phenotype of interest. Much of the research reviewed by Horwitz and Neiderhiser focused on broad indicators of both inherited traits and child outcomes and somewhat global indicators of family process. But, in tandem with

specifying the mechanisms of genetic transmissions, identifying and defining the behavioral, and observable, elements of a developmental trajectory is critical. And this articulation is required not only of the outcome of interest, such as “child adjustment,” but must be done at every level of the model.

So, for example, although the E in GE may be obvious to family researchers, if one wishes to trace developmental pathways from genes to behavioral outcomes with any degree of emphasis on the actual process, whether biological or behavioral, better articulation of the relevant features of E are necessary. Often, researchers assume that E must mean parenting behavior or other dimensions of the family environment. Such an assumption may be intuitively appealing, and in some cases correct, but it should not preclude looking at other elements of the environment. And this focus on family functioning and parenting behavior requires elaboration. Although considerable research has sought to understand the relations between parental behavior and a range of child developmental outcomes, much of this work has been conducted at a very broad level of analysis, using global constructs like attachment, warmth, and monitoring. Analyses of GE interactions reveal the need for models of family functioning that offer greater specificity regarding proximal processes that may be implicated in the effects of these relationships on children’s biological and behavioral functioning (Corter & Fleming, 1995).

Phenotypic specificity at the level of outcome is needed as well. Much of the work examining child adjustment has focused on broad indicators of the child’s functioning, such as externalizing and internalizing symptoms. Predicting to such indicators is less than satisfying because they are not very revealing of the specific ways in which children’s behavior or biology is being influenced or altered by the GE interplay. Moreover, many of the measures of child outcome that are used would best be described as general indicators of child functioning, given that individual scales reflecting particular clusters of symptoms are often correlated (for example, internalizing and externalizing) and given that parents are typically the reporters of the child’s functioning. To the extent that investigations can specify and observe particular behaviors or traits in a more nuanced way, identifying linkages to neural or physiological processes that are genetically influenced will be made easier, as will hypothesizing how environmental factors might alter the pathway to the behavioral phenotype.

Assessing GE Effects Developmentally

Horwitz and Neiderhiser noted that the use of cross-sectional designs to test GE interplay does not accurately reflect the complex transactions that may occur as development unfolds. Longitudinal designs that follow children and families over time are needed for this purpose. Such studies are a good first step for moving away from static models of GE interplay. The essential challenge here, though, goes beyond the empirical design. Implicit in a biopsychosocial framework is the notion that every level of analysis is participating in the process of change across time. Measuring change across time at different levels of functioning poses significant challenges, both methodologically and analytically. Selection of child outcomes measures, for example, depends on an appreciation of developmentally appropriate expectations for functioning, which may be known from a behavioral perspective, but are less known for biological indicators. Parenting behaviors, too, need to be sensitive to the developmental level of the child. Growth models depend on the ability to make comparisons across time. Phenotypic discontinuity is likely to be much greater over early development and understanding the source of that discontinuity is much more difficult as well. These challenges provide a context for understanding and interpreting GE effects, even when conducting longitudinal studies.

Conclusions

Horwitz and Neiderhiser provided a thorough review of behavior genetic research that addresses the important, but general, question of whether family factors alter the putatively “inherited” trajectories that lead to child adjustment outcomes. The answer to this question is clearly “yes.” Their review leaves us with a number of unanswered questions, though, and these questions are driven largely by conceptual considerations having to do with greater specificity regarding the how, what, and when of GE interplay. Adoption of a biopsychosocial framework that emphasizes the dynamic and transactional nature of the developmental system is essential to dispelling some pervasive myths about the predictive and independent role of either genes or environment in human adaptation and, if used to guide empirical work, may contribute substantially to our understanding of development across the lifespan. It is not necessary, though, for every research program to try to address all of these elements of development or each of these levels of analysis. Indeed, practical considerations make such an endeavor unlikely to be productive. Instead, integrating findings across carefully conducted studies of sufficient conceptual and empirical complexity will likely provide the greatest yield. Such an approach may also offer guidance as to the important points of entry for intervention and prevention work.

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