



Developmental Mechanisms Underlying the Legacy of Childhood Experiences

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ABSTRACT—*Developmental scientists tend to address questions about mechanism in ways that, ironically, are not especially developmental. More specifically, although we now have a great deal of data that suggest that childhood experiences have implications for human development, we know little about the time course of such effects or the dynamic mechanisms that might sustain them. Why? Because longitudinal data are rarely analyzed in a manner that can probe the developmental mechanisms by which earlier experiences are carried forward over time. In this article, we explore this paradox in detail, propose a solution, and review a set of published examples that implement the solution with a focus on the predictive significance of early maternal sensitivity. We conclude with suggestions for work in this area.*

KEYWORDS—early experience; developmental models; continuity

Developmental scientists have become increasingly interested in identifying the mechanisms by which a variety of risks and resources translate into (mal)adaptation. Such research has taken many forms, including identifying biological mechanisms underlying the effects of childhood experiences; for example, a growing number of studies address how childhood experiences are

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embodied in physiological functioning and how neurobiological and other physiological processes relate to subsequent behavioral outcomes (Murray-Close, in press; Obradović, 2012). Developmentalists have also studied mechanisms by leveraging methods for improving causal inference in domains where it is unethical or impossible to experimentally manipulate the focal developmental processes (Foster, 2010). For example, behavior-genetic designs allow researchers to untangle environmental and genetic contributions to the association between developmental inputs and outputs (Jaffee, Strait, & Odgers, 2012).

These trends in developmental science are important for many reasons, but they are not unique to developmental psychology. Researchers in many subdomains of psychology explore the brain regions that support social, affective, and cognitive processes (Miller, 2012). Similarly, sociologists, econometricians, and others have long championed careful attention to causal processes. Indeed, any discipline that relies on nonexperimental data must grapple with its inherent deficiencies vis-à-vis causal inference.

Developmental scientists have emphasized these broader trends, ironically, at the expense of studying mechanisms in a manner that is inherently developmental. Although we now have a great deal of data that suggest that childhood experiences have implications for human development, we know little about the *time course* of such effects or the *dynamic* mechanisms that sustain them. In fact, until we have a better understanding of whether specific risk factors and resources have enduring or transient consequences for development within given substantive research domains, research on biological (and other) mechanisms as well as the causal status of associations drawn from nonexperimental studies may be less informative than if we understood those issues.

Some may object and note that longitudinal research is thriving, a point with which we do not disagree. Nonetheless, the ways in which data drawn from such studies have been traditionally analyzed cannot speak to the dynamic mechanisms by which childhood experiences are carried forward over time. In this article, we explore this paradox in detail, propose a solution, and review a set of published examples that implement it. We conclude with suggestions for work in this area.

ALTERNATIVE MODELS OF DEVELOPMENT AND THEIR FORMAL IMPLICATIONS

Social developmental research has been marked by debates over the legacy of childhood experiences and in particular, the extent to which they matter in shaping outcomes later in life. For example, some scholars have suggested that early caregiving experiences are important in the short term but that the long-term consequences of those experiences dissipate as children develop (e.g., Kagan, 1980). As children grow older, they acquire novel competencies, forge new relationships, and encounter experiences unlike those in earlier life, both in content and valence. According to the revisionist perspective, each of these factors presents an opportunity to weaken the long-term association between a given childhood experience and later outcomes.

Other scholars have argued that childhood experiences may be sustained across development for a number of reasons (e.g., the nervous system is particularly plastic in early life relative to other stages; Bowlby, 1973). According to the enduring effects perspective, the effects of early experiences are preserved across time, shaping outcomes in relation to salient developmental tasks (Sroufe, Egeland, & Kreutzer, 1990).

Although these models have implicitly anchored debates in developmental psychology for decades (e.g., Fox & Rutter, 2010; Kagan, 1998; Lamb, Thompson, Gardner, Charnov, & Estes, 1984; Lewis, 1997; Simpson, Collins, & Salvatore, 2011), the field lacks a clear appreciation of exactly what these models predict about the effects of a given childhood experience. It might appear that a revisionist perspective, in which an earlier experience is superseded by contemporary experiences, would predict small or no associations over time, while the enduring effects perspective that assumes that a childhood experience plays a unique role in development would anticipate a large degree of predictive significance over time. But, the predictions made by these alternative frameworks are not so clear cut. To examine them more precisely, we considered formal mathematical models of each perspective and illustrated the models' implications for associations between developmental experiences and later outcomes (Fraley, Roisman, & Haltigan, 2013).

Because the enduring effects and revisionist dynamics share several assumptions, we modeled them within the same framework using a path modeling approach (see Figure 1). Specifically, an outcome variable of interest (e.g., social competence) has some degree of stability (path *c*) and is also influenced by factors external to the core variables being studied (represented by residual arrows). The two perspectives differ in the way they represent the influence of the focal developmental experience. According to the revisionist perspective, a given childhood resource or risk influences adaptation (path *a*). However, the effects of an earlier experience on subsequent outcomes are assumed to be indirect, with no direct association between (for example) early sensitivity and competence at, say, age 15. The paths labeled *b* in the diagram are assumed to equal zero.

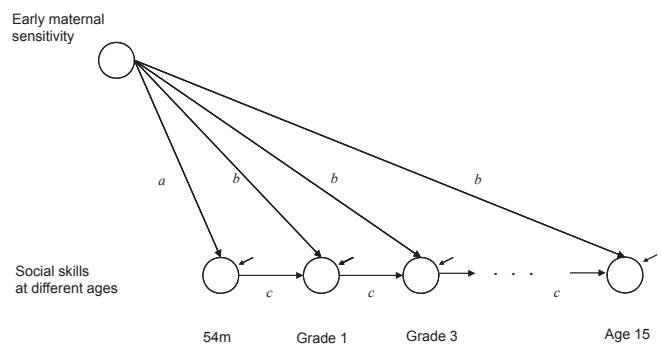


Figure 1. The core structural relations among variables according to revisionist and enduring effects perspectives. Both models assume that a focal developmental experience (here, early maternal sensitivity) may influence (path *a*) early outcomes (here, social skills), that those outcomes have some degree of stability over time (path *c*), and that those outcomes may be affected by experiences that are uncorrelated with the focal developmental experience (i.e., the residual arrows). The enduring effects model also assumes that the focal experience continues to have ongoing effects on outcomes across time (path *b*), whereas the revisionist model does not make this assumption (*b* = 0). Figure from Fraley et al. (2013). Published by the American Psychological Association. Adapted with permission.

The enduring effects model assumes that a focal developmental experience plays a unique role in development and can influence an outcome of interest at each point in time (Sroufe et al., 1990). As with the previous model, this one assumes that the outcome of interest can be influenced by many factors at any point in time. Moreover, like the revisionist model, the enduring effects model explicitly allows for a portion of the predictive significance of a given childhood experience to be indirect. However, this model also assumes that this experience (or, more precisely, its stable embodiment in the person) continues to influence the outcome in question over time as represented by the *direct* paths, labeled *b*, between sensitivity at Time 1 and competence at each assessment.

To illustrate the implications of these alternative ways of conceptualizing the influence of early experiences, we varied the values of these paths and solved the equations for the correlations of interest (for additional details, see the caption for Figure 2). The results for the revisionist model are illustrated in the left-hand portion of Figure 2. The curves illustrate the correlations between (for example) maternal sensitivity at Time 1 and social competence at varying points over time (e.g., ages 2 and 20). Several curves are shown to illustrate the kinds of curves that emerge in this developmental process. The correlations between the childhood experience and later outcomes start off moderately large but decay exponentially, approaching zero in the limit. In short, the revisionist model predicts that the association between a given experiential input and (mal)adaptation will eventually dissipate until it is nonexistent.

The consequences of assuming that developmental experiences have an enduring effect on developmental outcomes over time are striking, as illustrated in the right-hand portion of Figure 2. In contrast to the results from the previous model, the effects of

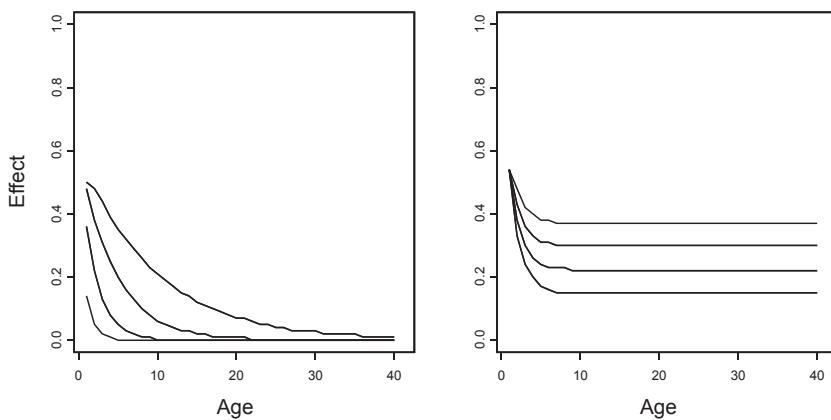


Figure 2. The effect of a given experience on developmental adaptation within a domain over time, under different models and parameter values. Both panels illustrate the theoretical association between experiences that took place early in life (e.g., maternal sensitivity in the first 3 years) and an outcome of interest (e.g., social skills) assessed across various ages. The left-hand panel illustrates the pattern of effects that should be observed if revisionist processes govern development in a given domain (Figure 1 with b paths set to zero). The different curves represent different associations between early experiences and later outcomes as a function of various parameter values. For example, the lowest curve represents the expected correlations between early experiences and later outcomes in situations in which the effect of the focal experience on outcomes is relatively weak; the curves become increasingly elevated as this parameter value is increased. The association between the focal childhood experience and subsequent outcomes approaches zero as age increases, regardless of the magnitude of early effects. The right-hand panel illustrates some prototypical curves that should be observed under an enduring effects model (Figure 1). Again, the different curves represent different associations between a focal experience and later outcomes as a function of various parameter values. For example, the lowest curve represents the expected correlations between the focal experience and later outcomes across time in situations in which the effect of the childhood experience in question on outcomes is relatively weak; the curves become increasingly elevated as this parameter value is increased. The effect of the childhood experience on subsequent outcomes is relatively constant across age, although those effects can be weak or strong in magnitude, depending on the parameter used for the effects of the focal childhood experience. Figure from Fraley et al. (2013). Published by the American Psychological Association. Adapted with permission.

the focal experience on the outcome of interest do not approach zero in the limit. Instead, they approach a nonzero value.

This modeling exercise yields two important lessons. First, the primary way developmentalists have addressed questions about the legacy of childhood experiences cannot differentiate between two fundamentally different ways of theorizing about developmental processes. In other words, developmental theory conflicts profoundly with developmental research. A typical prospective, longitudinal study measures experiences at some point during childhood and assesses the correlates of those experiences at a later point. If those childhood experiences are related to later outcomes, researchers conclude that those experiences played a role in organizing development. If those experiences are only weakly related or unrelated to later outcomes, researchers assume that those experiences were largely inconsequential in shaping development. Our modeling, however, indicates that the size of a single association does not differentiate the two models. Both models can explain strong or weak associations between childhood experiences and subsequent outcomes. As such, the traditional methodological approach for investigating development is, paradoxically, insensitive to the implications of alternative developmental models (for additional detail, see Figure 3).

Second, to investigate developmental mechanisms, the association between early experiences and subsequent outcomes must be examined over multiple assessment waves. In other words, instead of focusing only on whether a given experience is or is not related to later outcomes in traditional two-wave designs, the

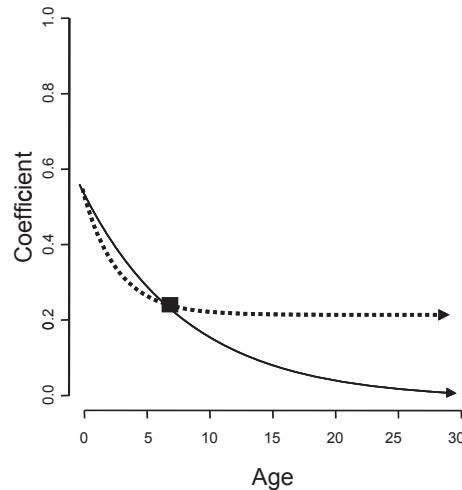


Figure 3. A methodological paradox illustrating the limitations of two-wave studies on developmental adaptation. The same observation (here a correlation of .22 between a given childhood experience and a later outcome) can be explained by a model that assumes that earlier experiences diminish in their significance over time (solid line) and a model that assumes that earlier experiences exhibit a persistent, even if modest, effect over time (dashed line). Figure from: Fraley et al. (2013). Published by the American Psychological Association. Adapted with permission.

way associations between a focal childhood experience and later outcomes are patterned across multiple assessments must be examined. Doing so can inform not only how childhood

experiences are related to later outcomes but also the latent developmental mechanisms that give rise to these associations.

AN EXAMPLE: EARLY MATERNAL SENSITIVITY IN THE SECCYD

We recently leveraged insights from the modeling work summarized here to explore the predictive significance of maternal sensitivity in the first 3 years of life. Given that the revisionist model is nested within the enduring effects model, the two models can be compared directly by estimating their parameters and comparing their relative fit to data. To illustrate this approach, we used data from the NICHD Study of Early Child Care and Youth Development (SECCYD; NICHD Early Child Care Research Network, 2005). This study is well suited for examining questions related to the enduring versus transient significance of early caregiving experiences in the normative range because it is a longitudinal investigation of more than 1,000 children tracked from infancy to age 18 that includes extensive data on the observed quality of early and later interpersonal experiences, as well as multimethod, multi-informant outcome measures of child adaptation. In our publications based on the SECCYD (Fraley et al., 2013; Haltigan, Roisman, & Fraley, 2013), for example, we have examined the consequences of the quality of participants' early interpersonal experiences in three domains central to developmental adaptation over time: (a) academic skills (assessed by teachers and testing), (b) social competence (reported by mothers and teachers), and (c) symptoms of psychopathology (again, reported by mothers and teachers).

We began our work in this area by simply examining the predictive significance curves generated by plotting correlations between an early sensitive caregiving composite and adaptation within the key outcome domains mentioned earlier (Roisman & Fraley, 2012a). Importantly, clear evidence emerged across these basic analyses that the association between early maternal sensitivity and these dependent measures varied in an absolute sense as a function of the outcome. Associations were largest for assessments of academic skills ($r_s \approx .3-.4$), next largest for social competence ($r_s \approx .2-.3$), and weakest for symptoms of psychopathology ($r_s \approx .1-.2$). These data also suggested enduring effects for most of the outcomes we examined—that is, the correlation between early sensitivity and subsequent assessments of the outcome were largely invariant to the time that had elapsed between the assessment of the outcome and early sensitivity. (One exception concerned mother-reported psychopathology, where the associations weakened over time.)

We followed up these analyses by fitting the model described in Figure 1 to the SECCYD data. In all cases except for mother-reported child symptoms of psychopathology, models in which the b paths noted in Figure 1 were constrained to zero fit the data significantly less well than ones in which b paths were either allowed to vary freely or were estimated but constrained to be equal. One important caveat, however, is that none of

these basic models fit the data well in an absolute sense. As such, we modified the models in several theoretically driven ways. The simplest modifications involved adding covariates (Figure 4a), which neither affected the findings reported earlier nor improved model fit.

Some scholars have argued that to the degree to which investigators find correlations between early experiences, such as maternal sensitivity, and later outcomes, one potential explanation for these associations is the stability of maternal experiences over time. According to this view (Lamb et al., 1984), early experience has no unique effect on later outcomes per se, but such associations may appear to persist because maternal sensitivity itself is relatively stable and can influence concurrently the outcomes of interest. To model this possibility (see Figure 4b), we included measures of maternal sensitivity across different ages and assumed that maternal sensitivity at each age had a concurrent influence on the outcome of interest. Once again, the basic findings were preserved and absolute fit of the models remained problematic.

Finally, to determine whether transactional processes (Sameroff & MacKenzie, 2003) could account for long-term effects of early sensitivity on developmental outcomes, we modeled second-order stability paths between outcome assessments (e.g., Grade 1 → Grade 3; see Figure 4c). This approach to approximating transactional dynamics is preferable to examining transactions with a measured environmental input (e.g., ongoing sensitive caregiving) because adding second-order pathways models all (even unmeasured) aspects of the environment by which, for example, social competence at T1 might become correlated with social competence at T3 (i.e., other than the effects of the focal experience and stability from the prior assessment of social competence at T2). In other words, this model respecification provides an omnibus test of whether transactional processes carry forward over time the effects of a focal developmental experience. This modification also did not affect the results reported earlier, but absolute fits of the model were acceptable, suggesting that enduring effects of early sensitivity may coexist with transactional processes that help sustain continuity in developmental outcomes.¹

RECOMMENDATIONS, CAVEATS, AND TRANSLATIONAL IMPLICATIONS

We framed our example in this report with respect to the question of whether experiences with primary caregivers early in life have enduring or transient implications for subsequent development. Nonetheless, our general concern about the importance of identifying the mechanisms that carry forward the effects of childhood experiences has implications for *any* substantive area

¹Transactional processes slow the rate at which the curves in Figure 2 reach their asymptotic values but do not affect whether the asymptotic values are zero or nonzero (Fraley & Roberts, 2005).

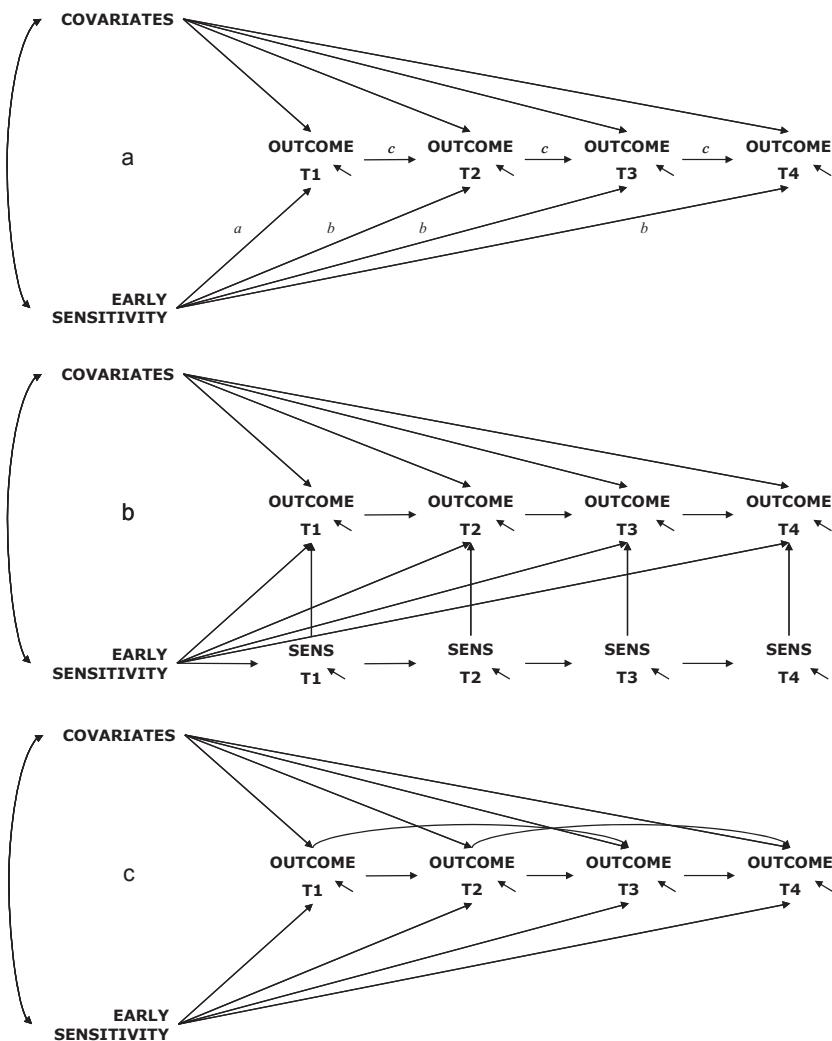


Figure 4. Extensions of the basic model presented in Figure 1. The upper panel (a) illustrates the basic model, but also includes various covariates (potential confounders like maternal education) that are assumed to have enduring effects on the outcome of interest. The second model (b) builds on the previous one by also taking into consideration the stability of maternal sensitivity and its ongoing effects on the outcomes of interest. The third model (c) builds on the covariates model by including second-order stability paths to represent the ways in which early processes may be carried forward via transactional mechanisms. T = time; SENS = sensitivity. Figure from: Fraley et al. (2013). Published by the American Psychological Association. Adapted with permission.

of developmental science concerned with the contributions of individual differences to social, emotional, cognitive, and biological development. Scholars in developmental psychology are concerned with a broad array of experiential inputs that are theoretically salient at varying times in the life course. The kinds of questions we have posed are just as relevant to understanding these domains and early versus later experiences as they are to understanding the ones we emphasized in our examples.

For this reason, social developmental research would benefit considerably by recommitting to studying the broad developmental mechanisms by which childhood experiences are reflected in adaptation, beginning with a concerted effort to characterize the time course associated with the effects of developmental experiences. While this can be accomplished in several ways, characterizing the asymptotic properties of the effects of a given developmental experience requires at least

three measurements of the dependent measure of interest as well as the use of analytic techniques—such as the structural models presented herein—that distinguish data generated from purely indirect effects of a focal childhood experience (as reflected in the revisionist model) from data that cannot be adequately explained without reference to *direct* effects of a given childhood experience (as in the enduring effects model).

Two caveats should be highlighted. First, in such work, maximizing the quality of causal inferences is essential. Although the theoretical models we have presented assume specific causal processes, the methods we have used do not allow causal processes to be tested in an unambiguous fashion.² Second, any

²In other work, we have attempted to improve causal inference about the predictive significance of early sensitivity by using a genetically informed (twin) design (Roisman & Fraley, 2012b).

analysis concerning the legacy of childhood experiences depends on the windows of time that are used for assessment. In the context of our empirical example, although the data were compatible with the notion that early experiences have an enduring impact on subsequent outcomes, that conclusion was based on data collected from early childhood through age 15. These conclusions could change if subsequent assessment waves beyond 15 point to a gradual decay in the predictive significance of early experiences.

Although attention to these issues would improve the quality of basic science in social developmental research, renewed attention to the developmental course of associations between childhood experiences and later outcomes also may have implications for translational efforts. If one is reasonably confident that the effects of experience in a specific domain are enduring, then the ways interventions are designed, parenting or legal advice is offered, and policy recommendations are made might differ from how they would be if the evidence supported a transient effect.

In fact, in applied contexts, researchers should be interested in the developmental course of the effects of childhood experiences regardless of whether enduring or transient effects predominate within a given domain. For example, suppose the effect of divorce on children's academic achievement is best characterized by a revisionist model in which children whose parents divorce tend to experience a host of disruptive transitions (e.g., moving to a new school) but that such disruptions eventually give way to stabilized development. Even so, knowing when divorce no longer normatively affects achievement (i.e., it reaches a zero asymptote at the population level) provides actionable information about when to intervene in the lives of the children still affected.

In short, the distinctions we have presented in this review point to a vast, uncharted territory in developmental science. The best way to begin surveying it is through empirical research that is sensitive to alternative ways in which early experiences are carried forward over time.

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