HHS Public Access

Author manuscript

*J Pers Soc Psychol*. Author manuscript; available in PMC 2021 June 01.

Published in final edited form as:

*J Pers Soc Psychol*. 2020 June ; 118(6): 1188–1206. doi:10.1037/pspi0000211.

# Development and Change in Attachment: A Multi-Wave Assessment of Attachment and its Correlates across Childhood and Adolescence

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## Abstract

This research examines the contextual factors that facilitate development and change in attachment during later childhood, adolescence, and early adulthood using a longitudinal cohort design involving 690 children (7-19 years old) and their parents. At each wave, a variety of interpersonal variables (e.g., parent-child stress) were measured. We examined alternative developmental processes (i.e., long-term, catalytic, and short-term processes) that have not been previously distinguished in attachment research. Pre-registered analyses revealed that non-developmental processes can explain the associations between almost all of the interpersonal variables of interest and attachment security, suggesting that previous research using traditional longitudinal methods may have misattributed non-developmental processes for developmental ones. For example, we found that friendship quality, although prospectively associated with attachment both in prior work and in the current study, was not developmentally associated with attachment. However, after controlling for non-developmental sources of covariation, we identified a number of developmental processes that may help explain change in attachment. For example, we found that initial levels of parental depression, as well as growth in parent-child stress, were related to growth in adolescent insecurity over three years. We also examined 12 genetic variants studied in previous research and found that they were not related to average levels or changes in attachment. These results highlight how distinguishing unique kinds of developmental processes allows for a more comprehensive understanding of attachment.

### Keywords

Attachment; Interpersonal Relationships; Development; Within-Person Change

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**Conflict of Interest:** The authors declare that they have no conflict of interest.

One of the basic tenets of attachment theory is that interpersonal experiences--particularly those with caregivers--shape children's beliefs about themselves and close others (Bowlby, 1969/1982). For example, children who are cared for in a consistently supportive manner are thought to develop secure attachment patterns; they come to believe that they are worthy of care, and that others will be available and responsive when needed. These beliefs, in turn, influence social and emotional development. Indeed, research has found that children who are securely attached to their caregivers are able to understand emotions better (Cooke, Stuart-Parrigon, Movahed-Abtahi, Koehn, & Kerns, 2016), have higher academic motivation (Duchesne & Larose, 2007), better quality friendships (Benson, McWey, & Ross, 2006), and fewer psychiatric symptoms (Madigan, Brumariu, Villani, Atkinson, & Lyons-Ruth, 2016) than those who are insecurely attached to their caregivers.

Given the relevance of attachment for a broad array of outcomes, it is important to understand how attachment security develops across childhood and into early adulthood. In the present study, we examine longitudinal associations between attachment security and several interpersonal variables. Specifically, we assessed children's self-reported attachment to their parents three times over three years, along with multiple indicators of their interpersonal environments that have been commonly identified as relevant to attachment security (e.g., caregiving experiences and friendship quality; see Fraley, Roisman, Booth-LaForce, Owen, & Holland, 2013, for a review). In addition we examined a number of genetic factors that have been previously reported to be associated with the development of attachment security (e.g., Costa et al., 2009; Gillath, Shaver, Baek, & Chun, 2008).

The present work expands on existing knowledge of attachment development in several novel ways. First, we show that traditional longitudinal studies on attachment have not been positioned to distinguish developmental from non-developmental associations. Second, we define and distinguish several distinct developmental processes: Long-term, catalytic, and short-term processes. We explain why these distinctions matter for attachment theory, and how they can be identified and studied in multi-wave datasets. Overall, we hope that this work will advance the current understanding of how attachment security develops during later childhood and adolescence, as well as the factors that predict its change over time.

## What Kinds of Factors are Relevant for Understanding the Development of Attachment Security?

### Attachment in Early Childhood

Attachment theory was developed by John Bowlby (1969/1982) as a framework for understanding children's relationships with their caregivers. Bowlby believed that young children have a propensity to develop emotional attachments to their primary caregivers, but that the quality of those attachments can differ considerably. Early attachment researchers investigated individual differences in attachment using the Strange Situation procedure (Ainsworth, Blehar, Waters, & Wall, 1978)--a laboratory task that involves separating and reuniting infants and their primary caregivers. Based on the Strange Situation, Ainsworth and her colleagues classified children's attachments into one of three broad categories: Secure, anxious-ambivalent, and avoidant. Secure children were visibly upset when

separated from their mothers, moved towards them for comfort when they returned, and were soothed by their presence. Anxious-ambivalent children were also visibly upset when their mothers left, but displayed conflicting behaviors towards them when they returned. Children classified as avoidant appeared relatively unconcerned with their mothers' separation and return.

According to attachment theory, individual differences in attachment patterns arise, in part, from variation in the experiences that children have with their caregivers (Weinfeld, Sroufe, Egeland, & Carlson, 1999). Attachment figures vary in their willingness or ability to provide care and support. As a result, children form differing beliefs and expectations about the availability and responsiveness of attachment figures. These beliefs, or *working models*, are reflected in the ways in which children organize their behavior, think about themselves and others, and regulate their emotions (see Bretherton & Munholland, 2008 and Collins, Guichard, Ford, & Feeney, 2004, for reviews).

Empirical research largely supports these theoretical assumptions. Studies have shown, for example, that maternal sensitivity in the first year of life predicts children's attachment classifications in the Strange Situation at age 1 (Ainsworth et al., 1978; De Wolff & van IJzendoorn, 1997). Moreover, secure classifications in the Strange Situation have been found to be associated with an array of psychological and behavioral outcomes, including fewer internalizing symptoms (McCartney, Owen, Booth, Clarke-Stewart, & Vandell, 2004; Shamir-Essakow, Ungerer, & Rapee, 2005) and behavior problems (Vondra, Shaw, Swearingen, Cohen, & Owens, 2001) in preschool-aged children, as well as more positive peer relationships in elementary-school children (Kerns, 1994; Schneider, Atkinson, & Tardif, 2001).

In addition to maternal sensitivity, prior research has identified a number of other parent-child factors that are relevant to understanding the quality of the caregiving environment. One of these factors is parental depression. Parents who are clinically depressed are generally limited in their emotional accessibility and are more likely to interact with their children in ways that are misaligned with children's psychological needs and disruptive to their cognitive and emotional development (Coyl, Roggman, & Newland, 2002; Murray & Cooper, 1997; Weissman, Paykel, & Klerman, 1972). Accordingly, children with depressed mothers during the postnatal period tend to be insecurely attached in later infancy and early childhood (Cogill, Caplan, Alexandra, Robson, & Kumar, 1986; D'Angelo, 1986; Martins & Gaffan, 2000).

The experience of chronic stress in the parent-child relationship has also been linked to insecure infant attachment patterns. Infants exposed to familial distress, such as strained parent-child relationships exacerbated by poor infant sleeping patterns, tend to be classified in the Strange Situation procedure as insecurely attached (Morrell & Steele, 2003; Sadeh, Tikotzky, & Scher, 2010). Furthermore, previous research suggests that young children who are chronically ill are more likely to be insecurely attached to their parents, and are also more likely to have less positive parent-child experiences and increased conflict with their caregivers compared to healthy children (Goldberg, Washington, Morris, Fischer-Fay, & Simmons, 1990). Altogether, these studies suggest that multiple aspects of the early

caregiving environment are relevant to understanding the development of children's attachment patterns in early childhood.

## Attachment in Later Childhood, Adolescence, and Early Adulthood

The majority of research on the antecedents and consequences of attachment involves young children, but a growing body of work has begun to focus on attachment in older children and adolescents as well (e.g., Kerns & Abtahi, 2017). Research in this domain has found that many of the factors that are relevant for understanding infant attachment--such as caregiving experiences--are also important for understanding the development of attachment beyond infancy. For example, Ruhl, Dolan, and Buhrmester (2015) followed 223 adolescents over 6 years and found that the quality of relationship experiences they had with their parents predicted concurrent levels of adolescent self-reported attachment security. Likewise, Seiffge-Krenke (2006) followed 112 adolescents over 7 years and found that those who were insecurely attached as adults (i.e., at age 21) tended to experience higher levels of stress in their parental relationships and use less adaptive coping styles than those who were securely attached.

In addition to the quality of caregiving experiences, a variety of other interpersonal factors are essential for understanding the development of attachment in later childhood, adolescence, and early adulthood (Dinero, Conger, Shaver, Widaman, & Larsen-Rife, 2008; Fraley et al., 2013; Salo, Jokela, Lehtimäki, & Keltikangas-Järvinen, 2011). One of the most important factors is peer relationships (e.g., Furman, Stephenson, & Rhoades, 2014). Previous research has found that adolescents who are securely attached to their parents tend to have better quality friendships than their insecure counterparts (e.g., Englund, Kuo, Puig, & Collins, 2011; Markiewicz, Doyle, & Brendgen, 2001). Moreover, experiences in close friendships are a significant predictor of the kinds of experiences that adolescents are likely to encounter in romantic relationships (Connolly & McIsaac, 2011). In fact, a study by Kochendorfer and Kerns (2017) reported that friendship quality predicted both adolescent romantic involvement and romantic relationship quality, above and beyond the variance explained by parent-child attachment.

Although a variety of factors have been found to predict attachment beyond early childhood, these factors are not static. Parent-child conflict, for example, tends to change over time (Schwarz, Stutz, & Ledermann, 2012). Similarly, estimates of friendship stability over time range from low to moderate (Bowker, 2004; Hardy, Bukowski, & Sippola, 2002; Lubbers, Snijders, & Van Der Werf, 2011). These findings raise the possibility that both the overall levels of such variables and *changes* in those variables across time could be associated with the development of attachment security in later childhood and adolescence.

In light of the existing literature, the present research focused on examining longitudinal associations between attachment, caregiving experiences, and friendship quality in children and adolescents. With respect to caregiving experiences, we assessed (a) the sensitive responsiveness of parents in structured observations, (b) parental depression, and (c) children's exposure to chronic stress in the parent-child relationship. We also assessed, wherever possible, how changes in those variables across time were related to changes in attachment. To be clear, although these caregiving variables are commonly discussed in the

attachment literature, we do not consider them to be exhaustive of all the potential constructs that may matter.

### Genetics and Attachment

Historically, attachment theorists have not emphasized genetic factors as precursors of attachment security. With the advent of new methods for studying genetic influence, however, an increasing number of scholars have begun to examine the ways in which genetic variation may be relevant to understanding individual differences in attachment (e.g., Costa et al., 2009; Gillath et al., 2008). Studies have found that a number of genetic variants are related to attachment patterns (e.g., Gillath et al., 2008). However, much of this work is based on sample sizes that used far fewer participants than are commonly recommended in the contemporary genetics literature (e.g., Chabris, Lee, Cesarini, Benjamin, & Laibson, 2015). Moreover, in light of publication bias concerns (i.e., only statistically significant associations being reported), it is possible that the associations that have been found are not representative of all tests that have been conducted to date. To overcome some of these limitations, we attempted to replicate previous findings with regards to 12 genetic variants that have been identified as relevant to attachment, and we fully report the results of those tests regardless of their outcomes.

## Development and Change in Attachment: Novel Ways to Conceptualize Developmental Processes

At its heart, attachment theory is a developmental perspective on why some people are more secure than others in their relationships with important people in their lives (e.g., their parents). That is, theorists assume that specific contextual and interpersonal factors have consequences for how secure or insecure children become. This assumption is often evaluated using longitudinal designs in which variation in one contextual variable at one point in time, such as parental depression, is used to predict variation in attachment at a later point in time (e.g., Bigelow et al., 2018). The predictive relationship between attachment and contextual variables can be quantified in a variety of ways, including, but not limited to, simple longitudinal correlations and cross-lagged regression coefficients. We will refer to these kinds of data as *prospective associations* from this point forward.

There are two major limitations of using prospective associations to understand attachment and its development. First, as we demonstrate below, prospective associations can emerge in longitudinal data for non-developmental reasons. As a result, the majority of research on attachment--even longitudinal research--has not been capable of separating developmental from non-developmental processes. Second, there are alternative developmental processes that could be relevant for understanding attachment, but they have not been distinguished in previous research. To advance attachment theory and research, it is necessary to acknowledge these alternatives and to empirically examine them. We outline both of these concerns in more depth below.

## Non-Developmental Processes can Masquerade as Developmental Processes

Prospective associations can emerge in longitudinal data even in the absence of developmental processes. To demonstrate this point, we draw on a well-known framework for modeling change in two or more constructs in multi-wave designs: A bivariate latent growth curve model (Curran, Howard, Bainter, Lane, & McGinley, 2014). According to this model (see Figure 1a), the trajectories of people's scores across time can be modeled using latent intercepts (i.e., where people are at the initial assessment) and slopes (i.e., people's rates of change). To ground this and subsequent examples, we focus on the association between parental depression and child insecurity over time (X and Y in Figure 1a, respectively). As reviewed above, a considerable amount of research has been devoted to examining parental depression as a risk factor for the development of attachment insecurity (see also Wan & Green, 2009, for an overview). Thus, the example of parental depression provides a valuable way to illustrate the key ideas and how they are relevant for understanding (or misunderstanding) developmental processes.

The expected prospective associations between parental depression and attachment insecurity across a variety of conceptually distinct contexts can be derived using covariance algebra. For example, if we assume the intercepts between these constructs are correlated, but there are no intercept-slope or slope-slope paths (i.e., Figure 1b), the model implies that there will nonetheless be prospective associations between parental depression and attachment assessed at a later point in time. Specifically, the expected value of the correlation between parental depression at Time 2 (X2) and Insecurity at Time 3 (Y3) is: 1 × VAR(Ix) × COV(Ix, Iy) × VAR(Iy) × 1. Thus, for any non-zero value of the covariance between the intercepts, there will be a non-zero prospective correlation between parental depression and insecurity.

What are the theoretical implications of this observation? This specific model (i.e., one that allows for correlated intercepts, but does not include intercept-slope or slope-slope correlations) is *not* a developmental model. It is a traditional latent trait model which assumes that two factors covary with one another for unspecified reasons.[1] The most common interpretation of such associations is that they are due to genetic confounding (e.g., Barbaro, Boutwell, Barnes, & Shackleford, 2017; Sherlock & Zietsch, 2018). That is, parental depression and child insecurity can be correlated, not because they are developmentally related to one another, but because genes shared by both mothers and their children give rise to both depression and insecurity. This non-developmental model, nonetheless, produces the kinds of patterns (i.e., prospective associations) that are commonly used to draw developmental inferences in the attachment literature.

## Alternative Developmental Processes

Traditional ways of thinking about development and change are often grounded in two-wave designs, in which a variable at one point in time (e.g., parental depression) is used to predict variation in another variable at a later point in time (e.g., insecurity). When multiple

[1]The parallel to latent trait models can be made more obvious by removing the slopes of X and Y in Figure 1b. In this case, the expected prospective association between X and Y is still positive if the covariance among the intercepts is positive, even if there is no developmental process giving rise to that covariance within the studied time frame.

assessment waves are available, however, it becomes clear that there are also multiple ways to conceptualize "change." For example, some changes might take place across relatively short timescales, whereas others might take place across longer ones. In addition, some changes are within-persons (i.e., changes over time, as captured by slopes) and some changes are between-persons, in which case the differences between people are used to make counterfactual comparisons. Below, we describe alternative developmental processes that have not been consistently distinguished in the attachment literature. We focus specifically on how these alternatives are relevant for understanding attachment and its development, and how they map onto the model shown in Figure 1a.

**Long-Term Processes.—**The first developmental process of interest is the kind that we suspect most scholars would have in mind if theorizing about how contextual and interpersonal experiences shape attachment in a multi-wave design. If parental depression plays a role in shaping child insecurity, then parents who become more depressed over time will tend to have children who become more insecure over time. In the context of a multi-wave study, long-term processes would be manifested in associations between the within-person trajectories of parental depression and the within-person trajectories of insecurity (i.e., slope-slope correlations; e.g., cov(Sx, Sy) in Figure 1a).

To be clear, these processes are not reflected in moment-to-moment changes (see below for a discussion on short-term processes). The trajectories modeled in a latent growth curve framework capture *long-term* patterns of development--patterns that exist above and beyond the occasion-to-occasion variation that might also describe a person's attachment security. It is only possible to "see" long-term processes by following people across multiple occasions over an extended period of time.

**Catalytic Processes.—**A second developmental process is what we refer to as *catalytic*. This represents a non-traditional way of thinking about attachment and its development, so we begin with a concrete metaphor to better explain the basic idea: Baking bread (e.g., Roberts & Hill, 2017). A hot oven provides a context that allows dough to rise. Once the oven has been pre-heated, however, the temperature remains constant and does not change over time. That is, *changes* in temperature are not the factor that enables the dough to rise per se. Rather, the heat is a catalyst or context that facilitates (or impairs) growth-related processes. To return to our running example of parental depression: It is possible that parental depression serves as a catalyst for growth in insecurity. If a parent is depressed and unable to provide supportive, responsive care to a child, that child may become more insecure over time. This developmental process would be manifested as a correlation between the intercepts of parental depression and the slopes of child insecurity (i.e., intercept-slope correlations; e.g., cov(Ix, Sy) in Figure 1a).

We think it is important to consider catalytic change in the study of attachment for at least two reasons, one practical and one conceptual. First, assume that researchers were to conduct a longitudinal study and discover that the slopes for parental depression were not related to the slopes for attachment insecurity. Would that pattern of results imply that parental depression does *not* play a role in the development of attachment? Using traditional perspectives on development, that would be the only logical conclusion to draw. But, once

one appreciates the possibility that development can operate via both long-term change and catalytic change, one can view development from a different lens. What might have appeared to be a non-developmental process at first glance (changes in one variable not being related to changes in the other) could reflect a catalytic developmental process in which early parental depression sets the stage for the development of insecurity.

Second, because the intercept-slope associations are estimated with the other paths in the model simultaneously, those associations can be interpreted as capturing something unique about the *enduring* value of early parental depression on child attachment. That is, the intercept-slope correlation represents the association between early parental depression and change in insecurity over time, controlling for the potential role of changes in parental depression. Because recent theoretical efforts have been devoted to trying to unpack the role of early vs. contemporaneous experiences in the development of attachment and related outcomes (e.g., Fraley, Roisman, & Haltigan, 2013; Raby, Roisman, Fraley, & Simpson, 2015), efforts to identify whether early and stable contextual factors are related to attachment-related outcomes is of critical importance. If, for example, researchers were to find evidence for long-term but not catalytic processes, this would imply that understanding *on-going change* is most essential for understanding development. But, if researchers also found evidence of catalytic change, it would imply that assessing contextual factors earlier in the developmental process provides additional valuable information about the development of attachment above and beyond on-going changes.

**Short-Term Processes.—**The third developmental process follows the same logic as the long-term process, but takes place on a shorter timescale. For example, we may expect that, when a parent experiences greater symptoms of depression, the child may also become more insecure. Those changes, however, may not persist over time and, as such, would not manifest as “growth” in insecurity. Instead, they would manifest as short-term deviations from a child’s trajectory of insecurity--deviations that are correlated with the parent’s deviations from their trajectory of depression.

We elaborate using a bread metaphor again. It could be the case that, on occasions when people are hungry, they are likely to eat more bread than they normally would. If this were true, one would conclude that these factors are dynamically coordinated--something that is of crucial developmental interest. However, the synchrony between two variables does not imply that the variables play a role in shaping individual differences over an extended period of time.[2] For example, one could not infer from short-term processes that people who become increasingly hungry over time (a period of 3 years) will also be increasing the rate at which they eat bread over that time period (i.e., long-term processes). Nor would we necessarily infer from short-term processes that early levels of hunger function as a catalyst for positive trajectories of bread eating over a period of three years (i.e., catalytic processes). In essence, when short-term changes in the two variables are coordinated, this does not necessarily mean that their long-term changes will be coordinated as well.

[2]In fact, one may legitimately question whether this last kind of change process represents true development given that (a) it takes place on a short timescale and (b), by definition, the changes are not sustained across time. Nonetheless, we classify it as a developmental process because it involves change, even if it is change that is not sustained.

Short-term processes are manifested in correlated residuals (e.g., cov(Ex, Ey) in Figure 1a). That is, after accounting for all other sources of development in the model, person-level deviations from the trajectory of one variable (e.g., parental depression) would be associated with person-level deviations from the trajectory of another variable (e.g., insecurity). Residuals can be correlated for a number of reasons (e.g., causal influences between them, third-variables that impact both). Nonetheless, they reveal something important about the dynamics of attachment. Namely, correlated residuals reveal that, in addition to or despite the absence of other forms of development, two variables may be synchronized to some extent over a brief period of time. This can be a crucial way to understand moment-to-moment changes in attachment, regardless of whether or not these fluctuations manifest themselves in long-term developmental processes.

## Summary

Existing developmental research has not been well-positioned to examine whether prospective associations between various interpersonal antecedents and attachment-related outcomes are due to actual developmental processes. We have demonstrated mathematically that non-developmental explanations can also give rise to prospective associations.[3] As such, it is critical to model both developmental and non-developmental sources of prospective associations when attempting to examine questions about attachment and its development. Without doing so, non-developmental processes can masquerade as developmental ones.

We have also argued that, in the cases when prospective associations can be attributed to developmental processes, there are different kinds of dynamic processes that could be used to explain the associations. In Table 1 we summarize these distinctions, and how they map onto the parameters in Figure 1a. Until now, the way that scholars have conceptualized development is loosely grounded in ideas about change (i.e., if parental depression changes, then child security will change as well). What we have shown here is that this logic can be applied to either long-term change (as manifested via slope-slope correlations) or short-term change (as manifested via correlated residuals). These two forms of development have dramatically different implications for understanding attachment and its development. The first, for example, captures something that is, by definition, more enduring because it references the long-term trajectories of attachment. The second captures something that might be consequential and powerful, but, by definition, is transient.

Finally, in the process of making these distinctions, we have called attention to a kind of developmental process that, until now, has not been featured in theoretical discussions of attachment. Catalytic processes refer to the possibility that early levels of contextual factors can provide a context for systematic development in attachment security. It is valuable to understand when catalytic processes are taking place because, although catalytic processes do not involve relationships between variables that are changing across time, they are,

[3]Similar concerns have been raised specifically in the context of cross-lagged panel models or autoregressive cross-lagged models (e.g., Hamaker, Kuiper, & Grasman, 2015). The most basic form of the problem is that, when correlated intercepts between variables are not modeled explicitly, the estimates of the cross-lagged paths are forced to do so, potentially leading to non-zero cross-lagged estimates even in situations where those parameters are known to be zero.

nonetheless, developmental in nature and have the potential to help explain how early contextual factors can shape attachment and its development.

## Overview of the Present Research

The purpose of the present study is to examine how children's interpersonal environments are related to development and change in attachment across time. We focused on two broad interpersonal contexts: Caregiving experiences and friendship quality. These contexts were selected because they have been commonly identified as relevant to attachment security. With regards to caregiving experiences, we examined three caregiving domains: (a) the sensitive responsiveness of parents, (b) parental depression, and (c) children's exposure to chronic stress in the parent-child relationship. In addition, we sought to replicate previous research by examining the associations between 12 genetic variants and attachment-related outcomes. In particular, we sought to better understand how the associations that arise among our chosen contextual variables and attachment might be explained by developmental vs. non-developmental accounts. We also evaluated which developmental processes helped to explain the associations (e.g., long-term or catalytic processes). Taken together, this research should help us identify whether developmental processes can explain the prospective associations among various factors and attachment and, if so, which kinds of developmental processes are relevant.

## Method

The data for the present study come from the Gene-Environment-Mood project (GEM)[4]. Children and adolescents in third, sixth, and ninth grade were recruited from participating school districts at two sites (Rutgers University and University of Denver) by letters sent to their homes. Six hundred and ninety youths, aged 7-19 years ($M$ = 11.84, $SD$ = 2.41), took part with one of their parents (the mother in 85% of cases) three times (18 months apart) over three years in an accelerated longitudinal design. Data from the full sample were used in the present analyses. Each cohort comprised approximately one-third of the sample and about half of the total sample was female (55.2%, $n$ = 381). Further demographic information can be found in Hankin et al. (2015).

An important point to note is that, unlike in infant research in which the Strange Situation serves as the gold standard, there is no consensus on how to best measure attachment in later childhood and adolescence. Some researchers have used story-stem interviews (e.g., Farnfield, 2016; Brown, Gustafsson, Mills-Koonce, & Cox, 2017), whereas others have used self-report instruments (e.g., Kerns, Aspelmeier, Gentzler, & Grabill, 2001). In the present study, we adopt self-report methods commonly used in social-personality psychology to assess attachment dimensionally. We recognize that there are debates in the field about the

[4]Fifty-one papers have been published to-date using the GEM dataset. However, only 3 of those 51 papers have been relevant to the study of attachment. None of the papers have examined the associations between attachment and any of the contextual/interpersonal variables included in the present work. Moreover, none of the published papers have attempted to distinguish between the kinds of developmental processes that we emphasize in the present work. One of the papers described the trajectory of attachment over time (Theisen, Fraley, Hankin, Young, & Chopik, 2018), another examined whether NR3C1 methylation moderated the effect of maternal support on attachment (Bosmans, Young, & Hankin, 2018), and a third paper examined attachment in relation to child depression (Khan, Fraley, Young, & Hankin, 2019).

best way to conceptualize and measure attachment (see Crowell, Fraley, & Roisman, 2016, for a review). However, self-report methods are widely used in adult attachment research in social-personality psychology (e.g., Brennan, Clark, & Shaver, 1998; Fraley, Heffernan, Vicary, & Brumbaugh, 2011) and are increasingly being used to study attachment in childhood and adolescence as well (e.g., Buist, Deković, Meeus, & van Aken, 2002; Crawford et al., 2006; Muris, Mayer, & Meesters, 2000; Ruhl et al., 2015).

## Measures

**Attachment.—**Parent-child attachment was assessed using the Experiences in Close Relationships-Relationship Structures (ECR-RS) questionnaire (Fraley et al., 2011) at baseline, 18-months, and 36-months. The ECR-RS is a 9-item self-report measure of attachment patterns. It can be administered with regard to a variety of relationships (e.g., parents, romantic partners) and was administered only with respect to the parent who accompanied the child in the present study. The ECR-RS consists of two subscales: 3 items measuring *attachment anxiety* and 7 items measuring *attachment avoidance*. Attachment anxiety reflects working models concerning negative beliefs about the self (e.g., that one is not worthy of care) and captures the extent to which people worry that others will not be available when needed. Attachment avoidance reflects working models concerning negative beliefs about others (e.g., that others are unreliable) and represents the extent to which people are comfortable with emotional intimacy and dependence. Children were asked to rate each item on the ECR-RS on a scale from 1 (strongly disagree) to 7 (strongly agree) with respect to the parent with whom they participated in the study. Example items include "I'm afraid this person may abandon me" (attachment anxiety) and "I don't feel comfortable opening up to this person" (attachment avoidance). Mean scores were calculated for each subscale and were used in all analyses. Reliability of the ECR-RS was good (Anxiety: $\alpha_{baseline}$ = 0.82, $\alpha_{18\text{-months}}$ = 0.83, $\alpha_{36\text{-months}}$ = 0.82; Avoidance: $\alpha_{\text{baseline}}$ = 0.81;, $\alpha_{18\text{-months}}$ = 0.80; $\alpha_{36\text{-months}}$ = 0.82).

**Caregiving environment.—**The caregiving environment was assessed in terms of (a) parental sensitive responsiveness, (b) parental depression, and (c) children's exposure to chronic stress in the parent-child relationship.

Parental sensitive responsiveness was measured using a parent-child conflict resolution task. This task was conducted at baseline and involved a 5-min videotaped interaction, during which the parent and the child worked to resolve an issue that they had both indicated was a problem between them (Foster & Robin, 1989). Trained raters coded the parent and the child on positive and negative behaviors (e.g., negative affect, positive affect, support, criticism). An initial training session was held to teach raters the coding system. Raters then coded two to three practice tapes at a time and met weekly to discuss discrepancies. In this way, raters were trained to reliability until intraclass correlation coefficients (ICCs) of 0.70 or greater were established with the criterion rater. Once reliability was obtained, approximately 20% of cases were double coded, and the remaining cases were single coded by the reliable, trained raters. In the current study, a composite of parental support and criticism was used to assess parental sensitive responsiveness. Support and criticism were selected because these two dimensions of sensitive responsiveness have been found to be particularly important to

children's social and emotional development (e.g., McCarty, Lau, Valeri, & Weisz, 2004; Felson & Zielinski, 1989). Final ICCs across pairs of coders ranged from 0.91 to 0.95 for positive parenting behaviors and .81 to .86 for negative parenting behaviors.

Parental depression was measured using parent reports on the Beck Depression Inventory II (BDI-II; Beck, Steer, & Brown, 1996) at baseline, 18-months, and 36-months. The BDI-II is a 21-item self-report measure designed to assess current depressive symptoms in adults. Parents were asked to respond to one of three statements for each item, with higher scores indicating greater levels of depressive symptoms. For example, statements for each item ranged from least severe "I do not feel sad" to most severe "I am so sad and unhappy that I can't stand it." The BDI-II is reliable and valid (Wang & Gorenstein, 2013). Reliability in the present study was good ($\alpha_{baseline} = 0.86$; $\alpha_{18\text{-months}} = 0.93$; $\alpha_{36\text{-months}} = 0.94$).

Children's exposure to chronic stress in the parental relationship was measured using the Youth Life Stress Interview (YLSI; Rudolph & Flynn, 2007). The YLSI was administered to children at baseline, 18-months, and 36-months. The YLSI is a revised version of the UCLA Child Episodic Life Stress and Chronic Stress Interview (Rudolph & Hammen, 1999) and is designed to elicit information about the nature, intensity, timing, and context of on-going stressors experienced by youth. It has demonstrated excellent reliability and validity in previous research (e.g., Conley & Rudolph, 2009; Rudolph & Flynn, 2007). For this report, we focused on chronic stress in the parent-child domain. Specifically, at each administration, interviewers asked youth to report information relevant to ascertaining stress in their parental relationship (i.e., with the parent who brought them into the study) over the past 18 months. Severity information on parent-child stress was presented to a team of three or more blind raters, who agreed upon the severity score on a scale from 1 (little/no stress) to 5 (severe stress).

**Friendship quality.—**The Network of Relationship Inventory – Short Form (NRI-S; Furman & Buhrmester, 1985) was used to assess the quality of children's friendships at baseline, 18-months, and 36-months. The NRI-S is a self-report measure that examines children's perceptions of their peer relationships in terms of two dimensions, *Social Support* and *Negative Interactions*. The NRI-S has 24 items, each of which is rated on a scale from 1 (little or none) to 5 (the most). It was administered to children with regard to both same-sex and opposite-sex friendships in the present study. Children's mean scores for Negative Interactions were reverse-scored and averaged with their mean scores for Social Support across same-sex and opposite-sex relationships in order to create a composite measure of Friendship Quality. Higher scores on Friendship Quality thus reflect better quality peer relationships overall. The reliability of both subscales in the present study was good (Social Support: $\alpha_{baseiine} = 0.92$; $\alpha_{18\text{-months}} = 0.92$; $\alpha_{36\text{-months}} = 0.92$; Negative Interaction: $\alpha_{baseiine} = 0.89$; $\alpha_{18\text{-months}} = 0.90$; $\alpha_{36\text{-months}} = 0.91$).

**Genetic variants.—**For genotyping, saliva samples were obtained at baseline from all study participants using Oragene (DNA Genotek, Ontario, Canada) collection kits. The samples were assayed for a number of single nucleotide polymorphisms (SNPs; for assay details, see Hankin et al., 2015). The SNPs used in the present study were identified by a literature search using the terms "attachment" AND ("genes," "SNP," "polymorphism," OR

"repeat"). Eligibility criteria for inclusion were as follows: (a) Previous research examined a main effect between the SNP and attachment patterns and (b) the SNP was available in the GEM dataset. Eligible SNPs included: FKBP5 (rs1360780 and rs3800373); mu-opioid receptor (OPRM1: rs1799971); dopamine receptor gene DRD2 (rs1800497); oxytocin receptor gene (OXTR: rs2254298 and rs53576); glucocorticoid receptor genes Bcl I (rs41423247), ER22/23EK (rs 6190), and GR-9β (rs6198); COMT $Val^{158}$Met (rs4680); mineralocorticoid receptor gene (MR, rs5522); and serotonin receptor gene 5-HT1A (rs6295).

## Data Analysis

We chose the Latent Curve Model with Structured Residuals (LCM-SR; Curran et al., 2014) as our primary modeling framework (see Figure 1a). It should be noted that, although there is no clear-cut way to estimate the power of multivariate models such as the LCM-SR, the present sample size provides us with 99.96% power to detect a population correlation of 0.20 using a two-tailed test. Given that our more complex multivariate analyses are based on the same concepts as bivariate ones, we consider the power to detect small associations in this dataset to be good.

For each analytic model, we began with the univariate version and systematically evaluated whether certain components could be removed or constrained without any significant decrement in model fit. We indicate where such simplifying assumptions were made in the analyses reported below. We then estimated separate multivariate LCM-SR models for attachment (including the dimensions of anxiety and avoidance) with caregiving experiences and friendship quality. A simplified LCM-SR model was used to examine associations between attachment security and parental sensitive responsiveness, however, because sensitive responsiveness was only measured at one time-point.

All analyses were conducted in R (version 3.4.2; R Core Team, 2015) using the *lavaan* package for latent variable modeling (Rosseel, 2012). Our basic analytic plan and scripts were pre-registered on the Open Science Foundation (OSF) project page before data analysis began (see https://osf.io/v5ymf/?view_only=294228c05bfd4d57b9d47fe9d7735317)[5]. The OSF project site contains the full output for the analyses that are summarized here.

For each multivariate model, we sought to answer several questions regarding development and change (see Table 1 for an overview of non-developmental and alternative developmental processes). First, can the associations between our chosen contextual variables and attachment be explained by non-developmental processes? If so, we would expect to observe correlated intercepts among the variables (e.g., cov(Ix, Iy) in Figure 1a). In cases where correlated intercepts emerge, it is necessary to account for those while investigating the other processes of interest. Second, to what extent are long-term changes in

[5]Our pre-registration includes another research question that we were unable to address. This question involves examining cross-lagged associations between the residuals of interest. However, the inclusion of autoregressive paths did not improve model fit in preliminary models containing attachment anxiety and avoidance simultaneously. Thus, we did not include autoregressive paths in the remaining models. One consequence of omitting these paths is that we were unable to estimate the cross-lagged paths, which require modeling autoregression. Our pre-registration also includes another variable, Social Competence. The analyses and results pertaining to this variable have been reported in Supplementary Material and are not discussed here, following reviewer suggestions.

our contextual variables and long-term changes in attachment correlated across time? Such associations are indicative of long-term developmental processes, and are revealed by correlations among the slopes for different variables, after controlling for other dynamic processes (e.g., cov(Sx, Sy) in Figure 1a). Third, to what extent do various contextual factors play a catalytic role in attachment development? Catalytic processes are revealed through associations between the intercepts of contextual/interpersonal factors and the slopes of attachment (e.g., cov(Ix, Sy) in Figure 1a). Finally, are short-term changes in various contextual variables associated with short-term changes in attachment? Short-term processes are manifested in correlated residuals among variables, after accounting for all other sources of systematic change and development (e.g., cov(Ex, Ey) in Figure 1a).

## Results

Means, standard deviations, and correlations between all study variables are reported in Table 2. Given the large number of variables being investigated, we present the results in three separate sections. In the first section, we describe some of the basic longitudinal patterns observed for attachment anxiety and avoidance. In the second section, we report the results of our multivariate LCM-SR models including attachment and each of our interpersonal variables in turn (see Table 3). Finally, we report the relations between attachment and genetic variables (see Table 4).

For each of the key results reported below, we report the unstandardized coefficient, its standard error, the *p*-value, and an estimate of the standardized coefficient. In cases where the paths were constrained to be equal over time (i.e., the covariances between the residuals at each wave), the standardized estimate we report, subscripted with the letter *s*, is based on the one estimated for the first assessment wave rather than an average across the three standardized coefficients. In all the models we included cohort as a covariate. Specifically, cohort was used to model variation in both the intercepts and slopes for each attachment dimension and the other variables of interest.

### Overall Longitudinal Patterns of Attachment

We first examined a model that included attachment anxiety and attachment avoidance as a way of descriptively summarizing the longitudinal patterns for attachment independently of the other variables. Overall, this model fit the data well, $\chi^2(8) = 14.080$, $p = 0.080$, CFI = 0.992, RMSEA = 0.033, SRMR = 0.023. Children in older cohorts tended to be initially less anxious ($\psi = -0.042$, $SE = 0.017$ $p = 0.015$, $\psi_S = -0.166$) and more avoidant ($\psi = 0.085$, $SE = 0.020$, $p < 0.001$, $\psi_S = 0.194$) than those in lower cohorts. Children in older cohorts also increased more in anxiety ($\psi = 0.032$, $SE = 0.012$, $p = 0.010$, $\psi_S = 0.219$), but did not increase in avoidance ($\psi = 0.003$, $SE = 0.014$, $p = 0.825$, $\psi_S = 0.012$) over time.

Across cohorts, children were on average relatively low in attachment anxiety (average intercept, $\alpha = 1.895$, $SE = 0.114$, $p < 0.001$) and avoidance ($\alpha = 2.203$, $SE = 0.134$, $p < 0.001$). Moreover, children tended to decrease in anxiety across time (the average slope, $\beta = -0.241$, $SE = 0.081$, $p = 0.003$), but did not increase or decrease in avoidance across time ($\beta = 0.092$, $SE = 0.090$, $p = 0.313$). There was considerable variance in the slopes of avoidance ($VAR = 0.344$, $SE = 0.063$, $p < 0.001$) and anxiety ($VAR = 0.116$, $SE = 0.050$, $p = 0.020$)

across people, suggesting that it is worthwhile to examine factors that may be related to individual differences in whether children become more or less anxious and avoidant over time.

## Parental Sensitive Responsiveness and Attachment

Our analytic strategy for parental sensitive responsiveness departs slightly from that used for the other variables because parental sensitive responsiveness was coded only in the initial assessment wave. Thus, we focused on the extent to which sensitive responsiveness in the initial assessment predicts initial levels of anxiety and avoidance (non-developmental processes) and trajectories of attachment over time (catalytic processes). We were unable to examine long-term (slope-slope correlations) or short-term (correlated residuals) processes for this construct.

Analyses revealed that children whose parents were more sensitive and responsive in their caregiving at the initial assessment wave were less likely to be anxious ($\psi = -0.179$, $SE = 0.050$, $p < 0.001$, $\psi_S = -0.249$) and avoidant ($\psi = -0.270$, $SE = 0.059$, $p < 0.001$, $\psi_S = -0.218$) in their initial levels of attachment. This suggests that, regardless of any of the developmental processes we are specifically targeting, there are reasons to believe that these variables will be prospectively related to one another for non-developmental reasons. Early sensitive responsiveness, however, was not related to changes in anxiety ($\psi = 0.014$, $SE = 0.035$, $p = 0.694$, $\psi_S = 0.033$) or avoidance ($\psi = -0.011$, $SE = 0.039$, $p = 0.781$, $\psi_S = -0.015$) across time, suggesting that sensitive responsiveness does not play a catalytic role in the development of attachment. In short, children who had more sensitive and responsive parents were more likely to be secure across all the assessment waves, but were not more likely to change in security over time. It is possible that these variables are associated for developmental reasons that took place prior to the initial assessments in this study. But it is also possible that these variables are related to one another for non-developmental reasons. Without additional assessment waves for responsivesness it is difficult to tease apart the alternatives.

## Parental Depression and Attachment

We next examined attachment anxiety, attachment avoidance, and parental depression using the LCM-SR framework. Overall, this model fit the data well, $\chi^2(18) = 24.894$, $p = 0.128$, CFI = 0.994, RMSEA = 0.024, SRMR = 0.021. Parents on average reported normative levels of depressive symptoms expected in a nonclinical sample ($\alpha = 5.643$, $SE = 0.639$, $p < 0.001$) and their average symptom levels did not change across time ($\beta = 0.028$, $SE = 0.387$, $p = 0.943$).

The children of parents who initially reported more depressive symptoms were no more or less likely to be anxious ($\psi = -0.039$, $SE = 0.292$, $p = 0.894$, $\psi_S = -0.013$) or avoidant ($\psi = -0.290$, $SE = 0.337$, $p = 0.390$, $\psi_S = -0.059$) with respect to attachment, which indicates that it is unlikely that there are non-developmental explanations for why parental depressive symptoms and attachment are associated. In addition, the slopes for parental depression were unrelated to the slopes for attachment anxiety ($\psi = -0.211$, $SE = 0.136$, $p = 0.120$, $\psi_S = -0.304$) and avoidance ($\psi = -0.162$, $SE = 0.147$, $p = 0.269$, $\psi_S = -0.140$), suggesting the

absence of a long-term process in which the growth in attachment is related to growth in parental depression. However, children were more likely to become anxious ($\psi = 0.650$, $SE = 0.205$, $p = 0.002$, $\psi_S = 0.383$) and avoidant ($\psi = 0.601$, $SE = 0.227$, $p = 0.008$, $\psi_S = 0.213$) over time if their parents initially reported more depressive symptoms. Thus, children who experienced early contexts of parental depression are more likely to be insecurely attached over time, suggesting catalytic processes.

We also examined the associations between the residuals at each wave to assess whether concurrent changes in attachment and parental depression were correlated across time (a short-term process). The associations between the residuals for parental depression and attachment anxiety were positive ($\psi = 0.360$, $SE = 0.165$, $p = 0.029$, $\psi_S = 0.090$). This was also the case for parental depression and avoidance, though the association was not statistically significant ($\psi = 0.325$, $SE = 0.175$, $p = 0.063$, $\psi_S = 0.105$). Thus, on occasions when parents reported greater depressive symptoms than usual, their children reported more attachment anxiety than usual.

In summary, there was no evidence of a non-developmental or long-term process with regards to the associations between parental depression and the attachment dimensions. However, the data suggested that there was evidence for catalytic processes, such that children with parents who initially reported higher symptoms of depression tended to become more insecure over time. Moreover, there was evidence of short-term change processes. That is, when parents reported greater depressive symptoms than one might expect given their trajectory, their children also reported more attachment anxiety than usual.

### Children's Chronic Stress in the Parent-Child Relationship and Attachment

We examined attachment anxiety, attachment avoidance, and parent-child relationship stress using the LCM-SR framework. Following the model-building process described by Curran et al. (2014), we removed non-essential assumptions from the model. Specifically, we removed the autoregressive paths for attachment and parent-child relationship stress. As a result of removing the autoregressive paths, we also removed the cross-lagged paths. Overall, the simplified model fit the data well, $\chi^2(18) = 30.266$, $p = 0.035$, CFI = 0.989, RMSEA = 0.031, SRMR = 0.031. Children on average reported normative levels of parent-child relationship stress ($\alpha = 1.724$, $SE = 0.074$, $p < 0.001$) and did not change in their average stress levels across time ($\beta = -0.038$, $SE = 0.050$, $p = 0.439$).

Next, we examined the different associations between the estimated intercepts and slopes for parent-child relationship stress and attachment across children. To evaluate the extent to which parent-child stress and attachment may be related for non-developmental reasons, we estimated the correlations among the intercepts for parent-child stress, anxiety, and avoidance. Children who initially experienced more parent-child relational stress tended to be more anxious ($\psi = 0.134$, $SE = 0.035$, $p < 0.001$, $\psi_S = .486$) and avoidant ($\psi = 0.107$, $SE = 0.039$, $p = 0.007$, $\psi_S = 0.228$) with respect to attachment.

We next examined long-term developmental processes between parent-child stress and attachment by estimating correlated slopes for these variables. Children who increased in parent-child relational stress across time also increased in attachment anxiety ($\psi = 0.039$, $SE$

= 0,017, $p = 0.020$, $\psi_S = 0.633$). The association between slopes for parent-child relational stress and attachment avoidance, however, was not statistically significant ($\psi = 0.020$, $SE = 0.019$, $p = 0.281$, $\psi_\delta = 0.184$).

To examine catalytic developmental processes we estimated the association between the intercepts of parent-child relationship stress and the slopes for anxiety and avoidance. These intercept-slope associations were not statistically significant for anxiety ($\psi = -0.032$, $SE = 0.023$, $p = 0.170$, $\psi_S = -0.213$), but were significant for avoidance ($\psi = 0.057$, $SE = 0.026$, $p = 0.028$, $\psi_S = 0.214$). Children who reported higher levels of parent-child stress early in the study were more likely than others to increase in avoidance over the next three years.

To examine short-term processes, we examined associations between the residuals at each wave in order to assess whether concurrent changes in attachment and parent-child relational stress were correlated across time. The association between the residuals for parent-child stress and attachment anxiety was positive and significant ($\psi = 0.040$, $SE = 0.019$, $p = 0.039$, $\psi_S = 0.071$). This was also the case for parent-child relational stress and avoidance ($\psi = 0.055$, $SE = 0.020$, $p = 0.007$, $\psi_S = 0.127$). Thus, on occasions when children experienced more relational stress than usual they also experienced more attachment anxiety and avoidance than usual.

To summarize, children who reported higher levels of parent-child relational stress were also more insecure at the beginning of the study, raising the possibility that prospective associations between these variables could be due to non-developmental processes. Controlling for that possibility, however, we were also able to examine alternative developmental processes. We found some evidence of long-term developmental processes. Specifically, children who experienced increasing levels of parent-child stress over time also became more anxious (but not more avoidant) over time. We also found some evidence of catalytic development: Children who had higher initial levels of parent-child stress became more avoidant (but not more anxious) over time. Finally, we found evidence of short-term change processes such that, on occasions when children reported greater parent-child stress, they also reported greater levels of anxiety and avoidance.

### Friendship Quality and Attachment

The next model examined attachment anxiety, attachment avoidance, and friendship quality using the LCM-SR framework. The model was simplified by removing the autoregressive paths for attachment and friendship quality, along with the cross-lagged paths. Overall, the model fit the data well, $\chi^2(18) = 26.639$, $p = 0.086$, CFI = 0.992, RMSEA = 0.026, SRMR = 0.025. Children on average reported relatively well-functioning friendships ($\alpha = 8.369$, $SE = 0.391$, $p < 0.001$) and the quality of those friendships did not systematically increase or decrease across time (B = 0.009, $SE = 0.245$, $p = 0.971$, $\beta = 0.010$).

In terms of non-developmental processes, children who started off with better quality friendships were less likely to be anxious ($\psi = -0.437$, $SE = 0.176$, $p = 0.013$, $\psi_S = -0.284$) or avoidant ($\psi = -0.585$, $SE = 0.201$, $p = 0.004$, $\psi_S = -0.223$) with respect to attachment. However, the slopes for friendship quality were not related to the slopes for attachment anxiety ($\psi = 0.030$, $SE = 0.082$, $p = 0.715$, $\psi_\delta = 0.096$) or avoidance ($\psi = -0.093$, $SE =$

0.090, $p = 0.301$, $\psi_{\delta} = -0.175$) over time. Thus, long-term processes do not explain the association between friendship quality and attachment. Similarly, the associations between the intercepts for friendship quality and the attachment slopes were not statistically significant for anxiety ($\psi = 0.017$, $SE = 0.120$, $p = 0.886$, $\psi_S = 0.020$) or avoidance ($\psi = 0.039$, $SE = 0.134$, $p = 0.772$, $\psi_S = 0.026$), suggesting that early friendship quality does not play a significant role in the growth of attachment.

We also examined the associations between the residuals at each assessment wave to assess short-term processes. The association between the residuals for friendship quality and attachment anxiety was significant and negative ($\psi = -0.225$, $SE = 0,096$, $p = 0.020$, $\psi_S = -0.082$). This was also the case for friendship quality and avoidance ($\psi = -0.205$, $SE = 0.101$ , $p = 0.043$, $\psi_S = -0.097$). On occasions when children experienced poorer friendship relationships than they typically did, they tended to report greater insecurity with their primary caregivers.

In short, the results show that there may be non-developmental explanations for why children who had higher quality friendships tended to be more secure. When controlling for non-developmental processes, there was no indication that either long-term or catalytic developmental processes explained the changes in friendship quality in relation to changes in attachment. There was, however, evidence for short-term processes, such that children who reported poorer quality of friendships than one might expect given their trajectory also reported greater insecurity with their primary caregivers than usual.

## Genetic Variants and Attachment

We again used a latent growth curve approach to examine the association between genetics and attachment. Because genetic data were acquired once (and, as such, are time-invariant in this design), we used those variables to predict both the intercepts and the slopes of attachment anxiety and avoidance. It is important to note that, because genetic variants are constant across time (even if genetic effects have the potential to vary; see Rosenquist et al., 2014), there are natural constraints on the kinds of developmental genetic processes that are relevant for understanding attachment. For example, long-term processes cannot take place because a person's genetic variants are constant across time and, thus, there are no slopes to estimate. Potential genetic effects are captured in two ways in our framework. First, genetic effects may manifest as non-developmental processes (i.e., intercept-intercept correlations). Second, genetic effects may be catalysts for change in attachment over time (i.e., intercept-slope correlations). That is, specific genetic variants could serve as a catalyst for the growth of (in)security over time. Our analyses examine these two possibilities.

The genetic variables we studied represented a combination of those for which people are homozygous or heterozygous with respect to specific alleles (e.g., for rs1360780, people have either two A alleles, two G alleles, or carry both forms) and variable tandem repeats. For the first kind of genetic variant, we opted to examine all pairwise combinations rather than grouping people *a priori* into groups believed to represent "risk factors" for attachment. For example, for rs1360780, we examined AA vs. AG/GG, AG vs GG/AA, and GG vs. AG/AA. For tandem repeats, we followed common practice and treated those repeats as quantitative variables. In examining non-developmental processes, we constrained the

parameters to allow the intercepts to correspond to the estimated attachment scores at the second of the three assessment waves. This was done as a way to model people's average scores rather than their initial scores.

The results are summarized in Table 4. In short, of the 120 tests that were conducted, only 4 were statistically significant. Given that this is fewer than the 5% that would be expected by chance without any adjustments for multiple-testing, we tentatively conclude that there is no evidence that the genetic variants previously identified as risk factors for attachment are associated with individual differences in attachment security.[6]

## Discussion

The purpose of the present work was to examine factors related to development and change in attachment during later childhood, adolescence, and early adulthood. To do so, we used data from a longitudinal study involving six hundred and ninety youths followed over three years (GEM; see Hankin et al., 2015, for an overview). We were particularly interested in examining how variables related to caregiving experiences and friendship quality were associated with development and change in attachment over time. We also examined whether genes were related to attachment patterns during this important maturational time-period.

One of the key innovations of this research was our ability to separate developmental from non-development processes, as well as being able to distinguish between different forms of development and change. Most longitudinal research on attachment tends to use a pre- and posttest approach to addressing questions (e.g., does parental depression at Time 1 predict attachment at Time 2?). We have shown that such approaches, even when based on longitudinal data, do not allow developmental processes to be separated from non-developmental ones. That is, prospective associations can emerge between variables for non-developmental reasons. Our findings indicate that for almost all of the contextual and interpersonal variables we examined, the initial levels of those variables and attachment were correlated (i.e., correlated intercepts). This raises the possibility that previous research that has examined the longitudinal relationship between these variables may be misattributing non-developmental processes as developmental ones.

Our approach allowed us not only to identify and control for this source of confounding, but also to examine alternative processes that might explain the development of attachment patterns. One kind of process we examined was long-term development--the ways in which long-term changes in contextual/interpersonal variables are related to long-term changes in attachment. We found that long-term processes were relatively rare in our sample. Although children who reported increasing levels of parent-child stress over time also reported

[6]A reviewer also suggested that we examine potential gene by environment interactions. Specifically, it is possible that some of the interpersonal/contextual factors upon which we have focused (e.g., parent-child stress) interact with specific genes to predict attachment patterns. To investigate this possibility, we examined 300 regression models in which each attachment dimension at Wave 3 was modeled as a function of each genetic variant, an interpersonal/contextual factor assessed at Wave 1, and the interaction of the two. Across all those analyses, only 7% of interactions were statistically significant at the alpha = 0.05 level. As such, there are not strong reasons to believe that gene by environment interactions, at least as assessed here, play a noteworthy role in explaining individual differences in attachment patterns. The full analyses and results are available in the Supplementary Materials.

increasing levels of attachment anxiety over time, such patterns were not evident for avoidance, parental depression, and friendship quality (see Table 3).

One of the novel developmental processes we examined was catalytic change--the extent to which initial values of a variable predict systematic growth in attachment. We found strong evidence of catalytic processes for parental depression and attachment. Namely, children whose parents were more depressed at the initial assessment were more likely than others to become both more anxious and more avoidant over three years. There was also evidence of catalytic processes for parent-child stress and attachment avoidance, but not for attachment anxiety. These findings are important because they highlight the possibility that some kinds of interpersonal factors may be relevant for understanding the development of individual differences in attachment, but via pathways that are not commonly considered in traditional developmental models.

Our final research question concerned short-term dynamic processes: When children experience more stress in their parental relationships than usual, for example, do they also experience more attachment insecurity than usual? After accounting for the broader longitudinal trends in the data, we found that the residuals were correlated for the majority of the variables we examined. Specifically, on occasions when children reported greater parent-child stress or poorer friendship quality than expected, they also reported greater attachment anxiety and avoidance than expected, given their trajectories. Additionally, when parents' reported more symptoms of depression than usual, their children also reported greater levels of attachment anxiety than they typically experience. These findings suggest that the way attachment changes, at least in the short-term, is not fully stochastic. Even relatively transient changes can be accounted for by short-term changes in contextual variables of interest, such as friendship quality or parent-child relationship stress.

## Implications for Attachment Theory and Research

One of the novel claims we have made in this article is that previous longitudinal research on attachment has not been able to examine developmental processes, despite its focus on prospective associations. Thus, although researchers have established that parental depression, for example, is prospectively related to child insecurity, we have shown that prospective associations can emerge in longitudinal data even in situations in which no development is taking place. As such, one of the major advances of the present work is to estimate and control these non-developmental sources of covariation as part of our efforts to examine attachment.

As a case in point, we found intercept-intercept associations between friendship quality and attachment, implying that children who have high quality friendships early on also tend to be more secure (less anxious and avoidant). But that pattern is essentially locked in place over time; there is not much evidence for on-going developmental processes.[7] That is, children

[7]We should clarity that we are not claiming that developmental processes cannot explain correlated intercepts between variables. But those developmental processes would need to take place before the study begins, implying that a process has been set in motion but is no longer operative. For example, it seems reasonable, on the basis of attachment theory and research, to assume that secure children select themselves into higher quality friendships than insecure children. But, based on the data examined here, there is little reason to believe that, beyond that process, friendships are contributing further to security experienced in the parent-child relationship.

with initially high functioning friendships do not become more secure over time (no catalytic processes), and children whose friendships improve in quality over time do not also become more secure over time (no long-term processes). These variables do show evidence of short-term dynamics, however, suggesting that on occasions when children experience better functioning friendships than might be expected, given their trajectories, they also experience more security than would be expected, given their trajectories. So the variables are "linked" in a dynamic manner. In the absence of this kind of dissection of alternative developmental processes, researchers would simply note that there is an inverse prospective association between friendship quality and attachment insecurity and conclude, potentially erroneously, that changes in friendship quality lead to changes in attachment or vice versa. For example, Fraley et al. (2013) concluded that changes in friendship quality over childhood and adolescence predicted individual differences in attachment at age 18. It is possible, however, that this finding can be due to non-developmental processes. Given that attachment was only assessed at one occasion in that research, it was not possible to distinguish alternative explanations for such a prospective association.

It is noteworthy that a different story emerges for some of the other variables. A sizeable literature has established that parents' depressive symptoms are associated with their child's attachment patterns (see Atkinson et al., 2000, and Martins & Gaffan, 2000, for meta-analytic reviews). Our results suggest that this finding might not be due to non-developmental confounds. That is, the intercepts for parental depression and child attachment were not significantly correlated. More importantly, our approach allows us to shed light on the *kinds* of developmental processes that may give rise to the prospective associations between parental depression and child attachment--something that previous research has been unable to do thus far. For example, there does not appear to be evidence of long-term developmental processes; changes in parental depression across time were not significantly associated with increases in insecurity across time. At first glance, that finding would seem to imply that there is *not* a developmental process to be identified or explained. There are, however, significant intercept-slope associations between these variables: Parents who were more depressed tended to have children who became more anxious and more avoidant over the course of three years. This indicates that parental depression may be a catalyst for the development of child insecurity.

One implication of this finding is that children's early and stable experiences with parental depression may provide a context that allows child insecurity to ferment. Thus, if one wished to intervene on parental depression, targeting it early could prove to be critical for mitigating against the growth of child insecurity. But, based on these data, there is little reason to believe that intervening later (i.e., creating within-person decreases in parental depression) would have consequences for changes in child insecurity. That is, we did not find that if parents became less depressed over time, their children also became more secure over time (i.e., long-term processes). This, however, is speculative, and the way actual interventions would operate could be distinct from what we might expect on the basis of naturalistic, longitudinal research.

We also found evidence that the associations between parent-child stress and attachment security may be due to a combination of non-developmental and developmental processes.

There were significant intercept-intercept correlations between parent-child stress and both attachment anxiety and avoidance. At the same time, we found that the types of developmental processes at play differed for each of the attachment dimensions. Long-term processes explained the development of parent-child stress and attachment anxiety, whereas catalytic ones explained the development of parent-child stress and attachment avoidance.

More generally, we did not find long-term processes to be relevant to the development of attachment avoidance, in particular, in any of our analyses. Only catalytic and short-term developmental processes explained attachment avoidance (see Table 3). This discrepancy is noteworthy because, if one were not considering catalytic processes (as is typically the case), it would seem as if attachment avoidance can not be understood via developmental processes, whereas attachment anxiety can. Our findings suggest that developmental processes are responsible for the associations between contextual factors and both forms of attachment insecurity (anxiety and avoidance), but the nature of those processes may be different for each attachment domain. Specifically, negative early interpersonal experiences are likely to set children up to increase in avoidance over an extended period of time, whereas both initial experiences and long-term changes in those experiences over time may be important to the development of attachment anxiety.

Beyond these points, another implication of our findings is that there is value in broadening the net when it comes to understanding the kinds of experiences that are relevant to the development of parent-child attachment security. A cursory reading of the attachment literature might suggest that sensitive responsiveness is the primary factor relevant to the development of attachment security (see Fraley, 2019, for a discussion). But, in fact, theorists have emphasized a number of interpersonal and contextual factors that might contribute to the development of security, including broader caregiving factors, such as parental depression and parent-child relationship stress, as well as broader interpersonal factors, such as friendships (Furman, Stephenson, & Rhoades , 2014). Our results strongly indicate that attachment continues to change over time. Thus, being able to identify some of the factors that predict that change can help us learn more about what makes some people secure or insecure in their relationships.

In addition to focusing on interpersonal factors, we examined the association between 12 previously studied genetic variants and attachment patterns. We found that fewer than 5% were significantly associated with individual differences in attachment. In addition, we found relatively little evidence for gene by environment interactions (approximately 7% of those tested were significant). These findings suggest one of two possible conclusions concerning the role of genetics in the development of attachment. One possibility is that genetic differences between people in commonly studied SNPs are not relevant to understanding why some people are more insecure than others. Or, relatedly, that they are relevant only in predisposing children to be more or less susceptible to family and peer influences (Belsky & Pluess, 2009). A third possibility is that the effect sizes of genetic factors that predict individual differences in attachment are too small to detect in the kinds of samples commonly used in attachment research. Indeed, in the last few years, much of the work examining the association between genetic polymorphisms and psychological and behavioral phenotypes has focused on obtaining sample with tens of thousands of people,

given the small effect sizes expected at the level of an individual SNP (Rietveld et al., 2014), or creating polygenic risk scores that take advantage of the aggregate effects of multiple genetic variants (De Moor et al., 2015). Similar advances may be necessary if this kind of work is going to be fruitful--and replicable--in attachment research (see also Roisman, Booth-LaForce, Belsky, Burt, & Groh, 2013).

## Strengths, Limitations, and Future Directions

One of the strengths of this research is that we were able to address one of the enduring questions in the study of attachment: What kinds of factors are associated with development and change in attachment styles? We addressed this question using a rich dataset with a moderately large sample size and with a set of methods and measures that are not all child self-report, including coded behavioral observations of parent-child interactions and parental caregiving, the gold-standard contextual stress interview for parent-child stress, and parent- and child-reports of psychological functioning. Moreover, with one exception, each construct was assessed multiple times over the course of three years, allowing us to decompose “change” in a variety of innovative ways. It is our hope that the findings from this study will spur future discussions on development and change in attachment. For instance, future research may wish to apply other developmental models, such as the double mediation model proposed by Simpson, Collins, Tran, and Haydon (2007), to examine specific patterns of associations between attachment and interpersonal variables. Another potential research avenue is to explore these associations with different time-scales of change, perhaps through the use of experience sampling methods (e.g., Torquati & Raffaelli, 2004).

Despite these strengths, there are at least four limitations of the present research that constrain the conclusions that can be drawn. First, the dataset only contains three assessment waves for attachment. Additional assessments would allow for more precise estimates of attachment trajectories and more opportunities to examine how deviations from those trajectories are related to other variables of interest. Second, although these data are longitudinal, they do not permit strong inferences about the causal relationships among the variables. It is possible that one reason trajectories of parent-child stress covary with trajectories of attachment insecurity over time is not because one variable causes the other. They could be mutually reinforcing one another or, alternatively, they could both be caused by a common and unmeasured variable. In short, attachment theory assumes causal relations among these variables, and, as such, we have tried to reflect those assumptions in our language. But the research design itself is not capable of revealing causal relations unambiguously and causal conclusions should not be drawn from these data. Third, 85% of the dyads in the dataset were mother and child. Thus, our inferences are limited to the mother-child relationship and generalizations to other types of relationships should be made cautiously. Finally, although our focus was on children’s attachments to their primary caregivers, there is now widespread recognition that people begin to transfer attachment-related functions from their parents to their peers (e.g., best friends, romantic partners) during late adolescence and early adulthood (see Hazan & Campa, 2013, for a review). Unfortunately, we only assessed attachment in the context of the parent-child relationship. It would be fascinating to learn more in future research about how some of the factors

examined here (e.g., parent-child stress) predict the development of attachment in non-parental relationships (e.g., Dinero et al., 2008).

In conclusion, the present research evaluates the kinds of processes that give rise to associations between various interpersonal factors and attachment security. Specifically, we disentangled developmental processes from non-developmental ones that have been confounded in traditional approaches. In addition, we examined how different types of developmental processes (i.e., long-term, catalytic, and short-term processes) account for various associations between interpersonal factors and attachment. As a whole, the findings from this study suggest that previous studies examining attachment development using traditional approaches may have mistook non-developmental processes for developmental ones. In addition, we have learned that different kinds of proceses may be relevant for understanding the developmental relationships among various contextual factors and attachment. For example, catalytic processes may be relevant for understanding parental depression and child insecurity, whereas long-term processes may be relevant for understanding parent-child stress and attachment anxiety. We encourage future researchers to differentiate developmental from non-developmental mechanisms and to identify new and improved ways of understanding the developmental antecedents of attachment patterns.

## Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

## Acknowledgments

**Funding:** This work was supported by National Institute of Mental Health (NIMH) Grants R01-MH 077195, R01-MH 077178, R01 MH109662, 1R01MH105501, 2R01MH077195, and 1R21MH102210.

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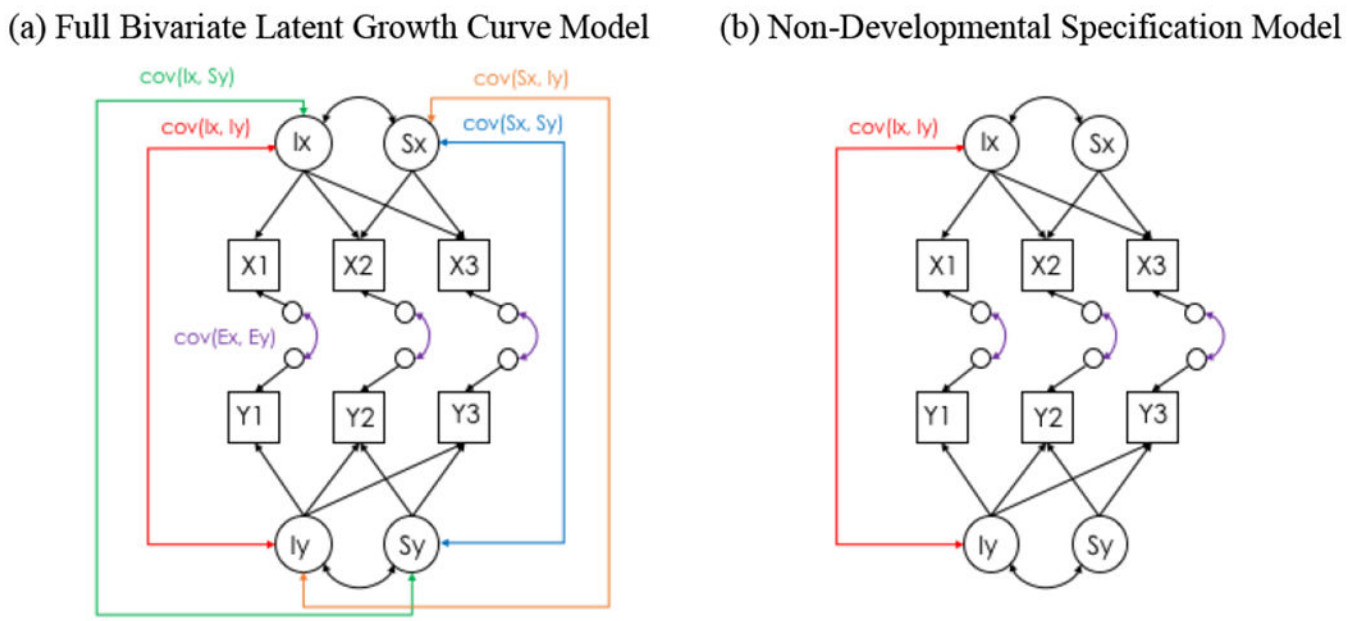


**Figure 1.**

Bivariate latent growth curve models. The left panel (a) illustrates a common bivariate latent linear growth curve model in which the trajectories of two variables are modeled as a function of their intercepts and slopes. The double-headed arrows between the error terms represent correlated residuals: The extent to which people's deviations from their trajectories on X are associated with their deviations from their trajectories on Y. The right panel (b) is a non-developmental specification of the model in which there are no correlated slopes or intercept-slope correlations. Nonetheless, if the intercepts are correlated, the model implies that there will be prospective associations between measures of X and Y.

**Table 1**

Theoretical distinctions between non-developmental and alternative developmental processes and the statistical operationalization for each process

| | | Alternative Developmental Processes | | |
|---|---|---|---|---|
| | **Non-developmental Processes** | **Long-term Processes** | **Catalytic Processes** | **Short-term Processes** |
| **Theoretical definition** | Non-devel opmental processes refer to processes that lead two variables to be associated across time for reasons that are not due to developmental mechanisms that took place during the study period (e.g., shared genetic effects, pre-study developmental effects). | Long-term processes reflect the extent to which long-term changes in a contextual variable (its trajectory) are related to long-term changes in attachment. | Catalytic processes refer to early experiences setting the stage for the long-term growth of attachment security or insecurity. | Short-term processes refer to the association between a contextual variable and attachment over a short period of time, net of all other sources of longitudinal association. |
| **Statistical Operationalization** | Associations between initial levels of the contextual variable and initial levels of attachment (i.e., intercept-intercept associations; e.g., cov(Ix, Iy) in Figure 1a) | Associations between the within-person trajectories of the contextual variable and within-person trajectories of attachment (i.e., slope-slope associations; e.g., cov(Sx, Sy) in Figure 1a) | Associations between the intercepts of the contextual variable and the slopes of attachment (i.e., intercept-slope associations; e.g., cov(Ix, Sy) in Figure 1a). | Associations between person-level deviations from the trajectory of the contextual variable and person-level deviations from the trajectory of attachment (i.e., correlated residuals; e.g., cov(Ex, Ey) in Figure 1a) |

**Table 2**

Means, standard deviations, and correlations between all study variables

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 T1 Anx. | 1 | | | | | | | | | | | | | | | |
| 2 T1 Avoid. | .33 | 1 | | | | | | | | | | | | | | |
| 3 T2 Anx. | .25 | .23 | 1 | | | | | | | | | | | | | |
| 4 T2 Avoid. | .12 | .49 | .31 | 1 | | | | | | | | | | | | |
| 5 T3 Anx. | .20 | .15 | .44 | .27 | 1 | | | | | | | | | | | |
| 6 T3 Avoid. | .09 | .39 | .33 | .63 | .39 | 1 | | | | | | | | | | |
| 7 T1 Sensitive | −.11 | −.18 | −.15 | −.17 | −.12 | −.18 | 1 | | | | | | | | | |
| 8 T1 Depress. | .05 | −.01 | .10 | .03 | .17 | .11 | −.10 | 1 | | | | | | | | |
| 9 T2 Depress. | .01 | .05 | .12 | .09 | .13 | .11 | −.10 | .51 | 1 | | | | | | | |
| 10 T3 Depress. | .07 | .07 | .04 | .05 | .12 | .12 | −.08 | .54 | .61 | 1 | | | | | | |
| 11 T1 Stress | .18 | .18 | .10 | .09 | .06 | .20 | −.15 | .09 | .11 | .14 | 1 | | | | | |
| 12 T2 Stress | .08 | .16 | .25 | .27 | .18 | .32 | −.20 | .10 | .16 | .10 | .40 | 1 | | | | |
| 13 T3 Stress | .00 | .10 | .20 | .19 | .19 | .29 | −.13 | .15 | .18 | .19 | .37 | .54 | 1 | | | |
| 14 T1 Friend. | −.16 | −.15 | −.15 | −.09 | −.09 | −.09 | .05 | −.11 | −.05 | −.06 | −.07 | −.02 | −.06 | 1 | | |
| 15 T2 Friend. | −.09 | −.14 | −.16 | −.16 | −.03 | −.12 | .02 | −.03 | −.04 | .01 | −.13 | −.08 | −.13 | .44 | 1 | |
| 16 T3 Friend. | −.13 | −.13 | −.14 | −.15 | −.16 | −.21 | .07 | −.02 | .01 | −.02 | −.16 | −.10 | −.07 | .37 | .46 | 1 |
| 17 Cohort | −.10 | .14 | .01 | .19 | .03 | .13 | −.08 | −.05 | .04 | −.02 | .09 | .17 | .10 | .07 | .04 | .11 |
| 18 Mean | 1.67 | 2.72 | 1.55 | 2.83 | 1.55 | 2.95 | 2.85 | 5.18 | 5.31 | 4.91 | 1.96 | 1.89 | 1.89 | 8.89 | 9.33 | 9.08 |
| 19 SD | 1.18 | 1.31 | 1.02 | 1.40 | 1.08 | 1.47 | 0.85 | 6.25 | 7.21 | 7.30 | 0.72 | 0.74 | 0.78 | 3.75 | 3.58 | 3.64 |

*Note*. Anx. = Attachment Anxiety; Avoid. = Attachment Avoidance; Sensitive = Parental Sensitive Responsiveness; Depress. = Parental Depression; Stress = Parent-Child Stress; Friend. = Friendship Quality.

**Table 3**

Summary of parameter estimates for interpersonal experiences and attachment

| | | Alternative Developmental Processes | | |
|---|---|---|---|---|
| | **Non-developmental Processes** | **Long-term Processes** | **Catalytic Processes** | **Short-term Processes** |
| **Sensitive Responsiveness** | **Anxiety:** −0.179 * (0.050)<br>**Avoidance:** −0.270 * (0.059) | N/A | **Anxiety:** 0.014 (0.035)<br>**Avoidance:** −0.011 (0.039) | N/A |
| **Parental Depression** | **Anxiety:** −0.039 (0.292)<br>**Avoidance:** −0.290 (0.337) | **Anxiety:** −0.211 (0.136)<br>**Avoidance:** −0.162 (0.147) | **Anxiety:** 0.650 * (0.205)<br>**Avoidance:** 0.601 * (0.227) | **Anxiety:** 0.360 * (0.165)<br>**Avoidance:** 0.325 (0.175) |
| **Parent-child Stress** | **Anxiety:** 0.134 * (0.035)<br>**Avoidance:** 0.107 * (0.039) | **Anxiety:** 0.039 * (0.017)<br>**Avoidance:** 0.020 (0.019) | **Anxiety:** −0.032 (0.023)<br>**Avoidance:** 0.057 * (0.026) | **Anxiety:** 0.040 * (0.019)<br>**Avoidance:** 0.055 * (0.020) |
| **Friendship Quality** | **Anxiety:** −0.437 * (0.176)<br>**Avoidance:** −0.585 * (0.201) | **Anxiety:** 0.030 (0.082)<br>**Avoidance:** −0.093 (0.090) | **Anxiety:** 0.017 (0.120)<br>**Avoidance:** 0.039 (0.134) | **Anxiety:** −0.225 * (0.096)<br>**Avoidance:** −0.205 * (0.101) |

Note.

* $p < 0.05$. Standard errors in parentheses.

## Table 4

Results for genetic analyses

| *Genetic Variant* | *Outcome* | *Contrast* | *B* | *SE* | *P* | *Beta* |
|---|---|---|---|---|---|---|
| rs1360780 | Avoidance (intercepts) | AA vs. (AG or GG) | 1.221 | 1.326 | 0.357 | 0.053 |
| | | AG vs. (AA or GG) | −0.537 | 0.755 | 0.478 | −0.041 |
| | | GG vs. (AA or AG) | 0.141 | 0.756 | 0.852 | 0.011 |
| | Avoidance (slopes) | AA vs. (AG or GG) | 0.586 | 0.857 | 0.494 | 0.045 |
| | | AG vs. (AA or GG) | 0.261 | 0.488 | 0.593 | 0.035 |
| | | GG vs. (AA or AG) | −0.449 | 0.488 | 0.357 | −0.060 |
| | Anxiety (intercepts) | AA vs. (AG or GG) | 0.478 | 0.617 | 0.438 | 0.052 |
| | | AG vs. (AA or GG) | −0.308 | 0.351 | 0.380 | −0.059 |
| | | GG vs. (AA or AG) | 0.153 | 0.352 | 0.663 | 0.029 |
| | Anxiety (slopes) | AA vs. (AG or GG) | 0.795 | 0.529 | 0.133 | 0.156 |
| | | AG vs. (AA or GG) | 0.373 | 0.301 | 0.216 | 0.129 |
| | | GG vs. (AA or AG) | −0.631 | 0.300 | 0.036 * | −0.218 |
| rs3800373 | Avoidance (intercepts) | AA vs. (AC or CC) | −0.130 | 0.762 | 0.865 | −0.010 |
| | | AC vs. (AA or CC) | −0.557 | 0.765 | 0.467 | −0.042 |
| | | CC vs. (AA or AC) | 1.914 | 1.269 | 0.132 | 0.087 |
| | Avoidance (slopes) | AA vs. (AC or CC) | −0.683 | 0.488 | 0.162 | −0.091 |
| | | AC vs. (AA or CC) | 0.505 | 0.491 | 0.304 | 0.067 |
| | | CC vs. (AA or AC) | 0.530 | 0.818 | 0.517 | 0.043 |
| | Anxiety (intercepts) | AA vs. (AC or CC) | −0.023 | 0.355 | 0.949 | −0.004 |
| | | AC vs. (AA or CC) | −0.305 | 0.356 | 0.392 | −0.058 |
| | | CC vs. (AA or AC) | 0.907 | 0.591 | 0.125 | 0.104 |
| | Anxiety (slopes) | AA vs. (AC or CC) | −0.585 | 0.303 | 0.053 | −0.206 |
| | | AC vs. (AA or CC) | 0.209 | 0.306 | 0.494 | 0.073 |
| | | CC vs. (AA or AC) | 1.056 | 0.506 | 0.037 * | 0.222 |
| rs1799971 | Avoidance (intercepts) | AA vs. (AG or GG) | 1.619 | 0.822 | 0.049 * | 0.113 |
| | | AG vs. (AA or GG) | −1.422 | 0.848 | 0.094 | −0.096 |
| | | GG vs. (AA or AG) | −2.228 | 2.332 | 0.339 | −0.055 |
| | Avoidance (slopes) | AA vs. (AG or GG) | −0.776 | 0.537 | 0.148 | −0.094 |
| | | AG vs. (AA or GG) | 0.786 | 0.553 | 0.156 | 0.092 |
| | | GG vs. (AA or AG) | 0.287 | 1.522 | 0.850 | 0.012 |
| | Anxiety (intercepts) | AA vs. (AG or GG) | 0.656 | 0.383 | 0.087 | 0.114 |
| | | AG vs. (AA or GG) | −0.566 | 0.395 | 0.152 | −0.096 |
| | | GG vs. (AA or AG) | −0.981 | 1.085 | 0.366 | −0.060 |
| | Anxiety (slopes) | AA vs. (AG or GG) | −0.479 | 0.330 | 0.146 | −0.151 |
| | | AG vs. (AA or GG) | 0.366 | 0.340 | 0.282 | 0.111 |
| | | GG vs. (AA or AG) | 1.080 | 0.933 | 0.247 | 0.120 |
| rs1800497 | Avoidance (intercepts) | AA vs. (AG or GG) | 0.068 | 1.614 | 0.966 | 0.002 |
| | | AG vs. (AA or GG) | −0.055 | 0.788 | 0.945 | −0.004 |
| | | GG vs. (AA or AG) | 0.036 | 0.760 | 0.962 | 0.003 |

| *Genetic Variant* | *Outcome* | *Contrast* | *B* | *SE* | *P* | *Beta* |
|---|---|---|---|---|---|---|
| | Avoidance (slopes) | AA vs. (AG or GG) | 0.888 | 1.063 | 0.403 | 0.055 |
| | | AG vs. (AA or GG) | 0.248 | 0.519 | 0.633 | 0.031 |
| | | GG vs. (AA or AG) | −0.431 | 0.501 | 0.390 | −0.056 |
| | Anxiety (intercepts) | AA vs. (AG or GG) | −0.117 | 0.755 | 0.877 | −0.010 |
| | | AG vs. (AA or GG) | 0.312 | 0.368 | 0.396 | 0.057 |
| | | GG vs. (AA or AG) | −0.263 | 0.355 | 0.460 | −0.050 |
| | Anxiety (slopes) | AA vs. (AG or GG) | 0.144 | 0.654 | 0.826 | 0.023 |
| | | AG vs. (AA or GG) | 0.247 | 0.319 | 0.439 | 0.079 |
| | | GG vs. (AA or AG) | −0.260 | 0.308 | 0.399 | −0.087 |
| rs2254298 | Avoidance (intercepts) | Continuous | −0.134 | 0.775 | 0.863 | −0.010 |
| | Avoidance (slopes) | Continuous | −0.137 | 0.495 | 0.782 | −0.018 |
| | Anxiety (intercepts) | Continuous | 0.433 | 0.360 | 0.229 | 0.081 |
| | Anxiety (slopes) | Continuous | −0.187 | 0.308 | 0.545 | −0.061 |
| rs53576 | Avoidance (intercepts) | Continuous | 0.840 | 0.572 | 0.142 | 0.085 |
| | Avoidance (slopes) | Continuous | 0.311 | 0.377 | 0.410 | 0.053 |
| | Anxiety (intercepts) | Continuous | 0.400 | 0.268 | 0.135 | 0.101 |
| | Anxiety (slopes) | Continuous | 0.181 | 0.232 | 0.435 | 0.082 |
| rs41423247 | Avoidance (intercepts) | CC vs. (CG or GG) | 0.298 | 1.274 | 0.815 | 0.013 |
| | | CG vs. (CC or GG) | −0.053 | 0.778 | 0.945 | −0.004 |
| | | GG vs. (CC or AG) | −0.055 | 0.758 | 0.942 | −0.004 |
| | Avoidance (slopes) | CC vs. (CG or GG) | −0.262 | 0.827 | 0.752 | −0.021 |
| | | CG vs. (CC or GG) | −0.358 | 0.505 | 0.478 | −0.046 |
| | | GG vs. (CC or AG) | 0.432 | 0.491 | 0.379 | 0.057 |
| | Anxiety (intercepts) | CC vs. (CG or GG) | 0.391 | 0.592 | 0.509 | 0.045 |
| | | CG vs. (CC or GG) | −0.209 | 0.361 | 0.562 | −0.039 |
| | | GG vs. (CC or AG) | 0.060 | 0.352 | 0.866 | 0.011 |
| | Anxiety (slopes) | CC vs. (CG or GG) | 0.772 | 0.505 | 0.126 | 0.160 |
| | | CG vs. (CC or GG) | −0.240 | 0.309 | 0.436 | −0.082 |
| | | GG vs. (CC or AG) | −0.046 | 0.301 | 0.879 | −0.016 |
| rs6190 | Avoidance (intercepts) | AG vs. GG | 0.679 | 2.221 | 0.760 | 0.018 |
| | Avoidance (slopes) | AG vs. GG | −0.394 | 1.447 | 0.786 | −0.018 |
| | Anxiety (intercepts) | AG vs. GG | −1.342 | 1.031 | 0.193 | −0.087 |
| | Anxiety (slopes) | AG vs. GG | −0.011 | 0.888 | 0.990 | −0.001 |
| rs6198 | Avoidance (intercepts) | AA vs. (AG or GG) | 0.358 | 0.825 | 0.665 | 0.025 |
| | | AG vs. (AA or GG) | −0.810 | 0.855 | 0.343 | −0.055 |
| | | GG vs. (AA or AG) | 2.631 | 2.120 | 0.215 | 0.072 |
| | Avoidance (slopes) | AA vs. (AG or GG) | −0.258 | 0.531 | 0.628 | −0.032 |
| | | AG vs. (AA or GG) | −0.127 | 0.551 | 0.818 | −0.015 |
| | | GG vs. (AA or AG) | 2.499 | 1.362 | 0.067 | 0.120 |
| | Anxiety (intercepts) | AA vs. (AG or GG) | 0.001 | 0.382 | 0.998 | 0.000 |
| | | AG vs. (AA or GG) | 0.018 | 0.396 | 0.965 | 0.003 |
| | | GG vs. (AA or AG) | −0.114 | 0.983 | 0.907 | −0.008 |

| *Genetic Variant* | *Outcome* | *Contrast* | *B* | *SE* | *P* | *Beta* |
|---|---|---|---|---|---|---|
| | Anxiety (slopes) | AA vs. (AG or GG) | 0.091 | 0.331 | 0.784 | 0.027 |
| | | AG vs. (AA or GG) | −0.184 | 0.343 | 0.591 | −0.054 |
| | | GG vs. (AA or AG) | 0.533 | 0.851 | 0.531 | 0.063 |
| rs4680 | Avoidance (intercepts) | AA vs. (AG or GG) | 0.673 | 0.912 | 0.460 | 0.042 |
| | | AG vs. (AA or GG) | −1.086 | 0.752 | 0.149 | −0.083 |
| | | GG vs. (AA or AG) | 0.780 | 0.824 | 0.343 | 0.055 |
| | Avoidance (slopes) | AA vs. (AG or GG) | −0.001 | 0.590 | 0.998 | −0.000 |
| | | AG vs. (AA or GG) | 0.280 | 0.487 | 0.566 | 0.038 |
| | | GG vs. (AA or AG) | −0.340 | 0.532 | 0.523 | −0.042 |
| | Anxiety (intercepts) | AA vs. (AG or GG) | −0.078 | 0.423 | 0.853 | −0.012 |
| | | AG vs. (AA or GG) | −0.450 | 0.349 | 0.197 | −0.087 |
| | | GG vs. (AA or AG) | 0.603 | 0.381 | 0.114 | 0.106 |
| | Anxiety (slopes) | AA vs. (AG or GG) | −0.298 | 0.365 | 0.415 | −0.085 |
| | | AG vs. (AA or GG) | 0.480 | 0.301 | 0.111 | 0.167 |
| | | GG vs. (AA or AG) | −0.331 | 0.329 | 0.315 | −0.106 |
| rs5522 | Avoidance (intercepts) | AA vs. (AG or GG) | −0.045 | 0.919 | 0.961 | −0.003 |
| | | AG vs. (AA or GG) | 0.307 | 0.944 | 0.745 | 0.019 |
| | | GG vs. (AA or AG) | −2.816 | 3.117 | 0.366 | −0.052 |
| | Avoidance (slopes) | AA vs. (AG or GG) | 0.678 | 0.596 | 0.256 | 0.074 |
| | | AG vs. (AA or GG) | −0.333 | 0.613 | 0.587 | −0.036 |
| | | GG vs. (AA or AG) | −4.142 | 2.016 | 0.040 * | −0.133 |
| | Anxiety (intercepts) | AA vs. (AG or GG) | 0.143 | 0.427 | 0.737 | 0.023 |
| | | AG vs. (AA or GG) | −0.007 | 0.439 | 0.988 | −0.001 |
| | | GG vs. (AA or AG) | −1.578 | 1.449 | 0.276 | −0.073 |
| | Anxiety (slopes) | AA vs. (AG or GG) | −0.149 | 0.368 | 0.686 | −0.042 |
| | | AG vs. (AA or GG) | 0.254 | 0.378 | 0.501 | 0.070 |
| | | GG vs. (AA or AG) | −1.059 | 1.248 | 0.396 | −0.088 |
| rs6295 | Avoidance (intercepts) | CC vs. (CG or GG) | 0.259 | 0.906 | 0.775 | 0.016 |
| | | CG vs. (CC or GG) | −0.121 | 0.758 | 0.873 | −0.009 |
| | | GG vs. (CC or AG) | −0.081 | 0.868 | 0.926 | −0.005 |
| | Avoidance (slopes) | CC vs. (CG or GG) | −0.183 | 0.591 | 0.758 | −0.020 |
| | | CG vs. (CC or GG) | 0.607 | 0.494 | 0.219 | 0.079 |
| | | GG vs. (CC or AG) | −0.628 | 0.566 | 0.267 | −0.071 |
| | Anxiety (intercepts) | CC vs. (CG or GG) | −0.109 | 0.421 | 0.796 | −0.017 |
| | | CG vs. (CC or GG) | 0.040 | 0.352 | 0.909 | 0.008 |
| | | GG vs. (CC or AG) | 0.047 | 0.404 | 0.907 | 0.008 |
| | Anxiety (slopes) | CC vs. (CG or GG) | −0.641 | 0.362 | 0.077 | −0.184 |
| | | CG vs. (CC or GG) | 0.533 | 0.303 | 0.079 | 0.180 |
| | | GG vs. (CC or AG) | −0.116 | 0.349 | 0.740 | −0.034 |

* $p < 0.05$