

# Journal of Personality and Social Psychology

## **Interpersonal and Genetic Origins of Adult Attachment Styles: A Longitudinal Study From Infancy to Early Adulthood**

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Online First Publication, February 11, 2013. doi: 10.1037/a0031435

### CITATION

Fraley, R. C., Roisman, G. I., Booth-LaForce, C., Owen, M. T., & Holland, A. S. (2013, February 11). Interpersonal and Genetic Origins of Adult Attachment Styles: A Longitudinal Study From Infancy to Early Adulthood. *Journal of Personality and Social Psychology*. Advance online publication. doi: 10.1037/a0031435

# Interpersonal and Genetic Origins of Adult Attachment Styles: A Longitudinal Study From Infancy to Early Adulthood

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One of the assumptions of attachment theory is that individual differences in adult attachment styles emerge from individuals' developmental histories. To examine this assumption empirically, the authors report data from an age 18 follow-up (Booth-LaForce & Roisman, 2012) of the National Institute of Child Health and Human Development Study of Early Child Care and Youth Development, a longitudinal investigation that tracked a cohort of children and their parents from birth to age 15. Analyses indicate that individual differences in adult attachment can be traced to variations in the quality of individuals' caregiving environments, their emerging social competence, and the quality of their best friendship. Analyses also indicate that assessments of temperament and most of the specific genetic polymorphisms thus far examined in the literature on genetic correlates of attachment styles are essentially uncorrelated with adult attachment, with the exception of a polymorphism in the serotonin receptor gene (*HTR2A* rs6313), which modestly predicted higher attachment anxiety and which revealed a Gene  $\times$  Environment interaction such that changes in maternal sensitivity across time predicted attachment-related avoidance. The implications of these data for contemporary perspectives and debates concerning adult attachment theory are discussed.

*Keywords:* adult attachment, attachment styles, longitudinal, development, SNPs

*Supplemental materials:* <http://dx.doi.org/10.1037/a0031435.supp>

During the last 30 years, attachment theory has become one of the leading theoretical frameworks for the social psychological study of close relationships and personality dynamics (Mikulincer & Shaver, 2007). The majority of attachment research has empha-

sized individual differences in self-reported *attachment styles*—relatively enduring patterns of thoughts, feelings, and behaviors in close relationships. Research has demonstrated that adult attachment styles have broad consequences for interpersonal functioning, emotion regulation, and well-being. For example, people who are relatively secure with respect to attachment are more likely than those who are insecure to experience satisfaction and to report high levels of commitment in their marital and dating relationships (e.g., Frei & Shaver, 2002; Tucker & Anders, 1999). In addition, their relationships are characterized by less conflict (e.g., Campbell, Simpson, Boldry, & Kashy, 2005; Simpson, Rholes, & Phillips, 1996) and tend to be more resistant to dissolution and divorce (Davila & Bradbury, 2001; Kirkpatrick & Davis, 1994). Individuals who are relatively secure in their attachment orientation are also less likely than others to report depressive symptoms (e.g., Carnelley, Pietromonaco, & Jaffe, 1994; Hankin, Kassel, & Abela, 2005) and more likely to report higher levels of self-esteem (e.g., Bartholomew & Horowitz, 1991) and to cope more effectively in response to stressful events (e.g., Berant, Mikulincer, & Shaver, 2008).

Although the consequences of attachment styles for psychological functioning have been well documented, the developmental antecedents of attachment styles have not. To be clear, it is not the

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Collection of the age 18 data was supported by Eunice Kennedy Shriver National Institute of Child Health and Human Development Grant HD054822 to Cathryn Booth-LaForce. The analyses of these data were supported in part by National Science Foundation Grant BCS-0443783 to R. Chris Fraley and National Science Foundation Grant BCS-0720538 to Glenn I. Roisman and R. Chris Fraley.

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case that the antecedents of attachment are merely of tangential interest to adult attachment theorists. Indeed, one of the core assumptions of attachment theory is that individual differences in adult attachment styles are a function of variation in peoples' developmental histories (Hazan & Shaver, 1987; Mikulincer & Shaver, 2007). However, prospective research on the antecedents of self-reported attachment style has been lacking due to the time and expense involved in conducting prospective research. As such, one of the foundational assumptions of the social psychological approach to adult attachment remains largely untested.

Our objective in this article is to help fill this gap by examining the antecedents of adult attachment styles using longitudinal data from the National Institute of Child Health and Human Development (NICHD) Study of Early Child Care and Youth Development (SECCYD). The SECCYD is particularly well suited for this purpose because it is based on a large, longitudinal sample of children who were assessed on multiple occasions from birth to age 15, with a follow-up study of participants' attachment styles at age 18 (see Booth-LaForce & Roisman, 2012). Moreover, the study contains measures of a number of constructs (e.g., maternal sensitivity, the quality of peer relationships) that have been hypothesized to predict variation in adult attachment styles. It is our hope that this research can help fill a gap that has been present for decades in the social psychological literature on adult attachment while also helping to advance the field's understanding of the origins of adult attachment styles.

### Overview of Attachment Theory and the Origins of Attachment Styles

Attachment theory emphasizes the role of early experiences in shaping the beliefs children construct concerning the responsiveness and trustworthiness of significant others. According to the theory, an individual who is cared for in a responsive and consistent manner develops the expectation that others will be available and supportive when needed (Ainsworth, Blehar, Waters, & Wall, 1978). Such expectations, or *working models*, contribute to the way people subsequently regulate their attachment behavior and can have an important impact on shaping an individual's social development and interpersonal relationships. Research on infant-caregiver attachment indicates that children who have sensitive and responsive caregivers early in life are more likely to be classified as secure in the Strange Situation (Ainsworth et al., 1978; De Wolff & van IJzendoorn, 1997). Moreover, children who are classified as secure at 1 year of age are more likely to forge positive relationships with their peers in early childhood (Elicker, Englund, & Sroufe, 1992; Kerns, 1994), to be judged as ego resilient by their teachers (Arend, Gove, & Sroufe, 1979), and to have well-functioning friendships in adolescence (Englund, Kuo, Puig, & Collins, 2011).

Social psychologists who use attachment theory as a means of understanding individual differences in close relationships and adult personality dynamics have adopted a similar kind of framework for conceptualizing individual differences. Specifically, social psychologists have assumed that in addition to the influence of ongoing relational experiences, interpersonal experiences across childhood and adolescence play a role in shaping individual differences in adult attachment styles (Hazan & Shaver, 1987). Social psychologists have emphasized three broad categories of antecedents to adult attachment: (a) maternal sensitivity and various factors that might affect the quality of the childhood caregiving environment (e.g., maternal depression, father absence), (b) the emerging social competence of the individual, and (c) the quality of the individual's peer relationships.

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### Maternal Sensitivity

The first of these factors, maternal sensitivity, has been emphasized the most in the attachment literature. In short, sensitivity refers to the extent to which the primary caregiver is available and appropriately responsive to the individual's needs. Over the course of repeated interactions with a sensitive caregiver, it is assumed that the individual learns that others will be available when needed, and this sense of security, in turn, provides a psychological resource that facilitates exploration, autonomy, and psychological well-being (B. C. Feeney & Thrush, 2010; Mikulincer & Shaver, 2007).

A number of investigators have examined the association between early sensitivity and adult attachment styles through the use of retrospective reports. These studies generally reveal that adults who recall warm, loving relationships with their early attachment figures are more likely to rate themselves as secure in attachment. For example, Hazan and Shaver (1987) found that adults who classified themselves as secure were more likely to describe their early experiences with their parents as being affectionate, caring, and loving. Adults who classified themselves as insecure, in contrast, were more likely to describe their parents as cold or rejecting (see also Collins & Read, 1990).

Theorists have also called attention to a number of contextual factors that may impact the quality of the caregiving environment. Maternal depression, for example, interferes with the parent's ability to provide a supportive environment for the child (Cummings & Davies, 1994; Teti, Gelfand, Messinger, & Isabella, 1995). Mickelson, Kessler, and Shaver (1997) found in a large population-based survey that individuals who reported that their parents had experienced depressive episodes when they were young were more insecure in their attachment orientation. Similarly, Davila and her colleagues found that young adults who were secure across two assessment waves were less likely than those who were not to report a history of family psychopathology, including depression (Davila, Burge, & Hammen, 1997).

Moreover, the quality of the relationship between the parents themselves may play a role in shaping the quality of parenting (e.g., Rhoads, Simpson, & Blakely, 1995; Selcuk et al., 2010) and the attachment styles that the individual develops. Parental divorce, father absence, and high parental conflict all have the potential to signal to the child that other people may not be available, dependable, or reliable. These kinds of ideas have been emphasized most explicitly by attachment theorists inspired by life history perspectives on development (e.g., Belsky, Houts, & Fearon, 2010; Simpson & Belsky, 2008). Researchers have found, for example, that adults who indicate that their biological parents divorced are more likely to report insecure attachment styles (Mickelson et al., 1997). In addition, researchers have found that early contextual stressors, broadly defined (e.g., father absence, low socioeconomic status), are related to self-report measures of insecure attachment styles in adulthood (e.g., Chisholm, Quinlivan, Petersen, & Coall, 2005).

## Social Competence

Adult attachment theorists have also argued that early experiences accumulate in a manner that contributes to the child's developing social skills and competence—skills that have the potential to shape later peer relationships and one's developing attachment style (e.g., Bartholomew & Horowitz, 1991; Englund et al., 2011). Indeed, in many respects, the child's developing sense of competence, cooperation, and self-control are considered to be the foundation upon which adult attachment styles are built (e.g., Mikulincer & Shaver, 2007).

The association between social competence and adult attachment has primarily been investigated concurrently in social psychological research. Bartholomew and Horowitz (1991), for example, found that relatively secure individuals were more likely to have high self-confidence and to express greater interpersonal warmth. Research has also found that secure adults are more empathically accurate in their relationships (Simpson et al., 2011) and are better able to seek and provide support during stressful and challenging situations (Collins & Feeney, 2000).

## Friendship

Importantly, social psychologists have not focused exclusively on the family of origin in theorizing about the roots of adult attachment styles. According to many theorists, friendships—especially those that develop in adolescence and early adulthood—play a role in shaping attachment orientations (e.g., Fraley & Davis, 1997; Furman, Simon, Shaffer, & Bouchey, 2002; Nickerson & Nagle, 2005). Although parents still play an important role in their child's development, peer relationships are some of the first extrafamilial contexts in which issues concerning intimacy, trust, and support are explored and negotiated. Some research has suggested that, for many people, close friends can serve important attachment functions (e.g., safe haven and secure base functions; see Fraley & Davis, 1997; Trinke & Bartholomew, 1997; Zeifman & Hazan, 2008) and that individuals who have higher quality friendships are more likely to be secure in their attachment orientation (e.g., Bartholomew & Horowitz, 1991).

## Previous Longitudinal Research

To summarize, social psychologists generally assume that attachment styles, as they are conceptualized and studied in adulthood, are a function of ongoing interpersonal experiences (Mikulincer & Shaver, 2007). But above and beyond contemporary influences, attachment styles are assumed to have their origins in (a) the quality of caregiving experiences across development, (b) social competence, and (c) the quality of peer and friendship relationships. Much of the research that has investigated these antecedents, however, has been based on retrospective measures of the interpersonal environment (making the reports subject to reconstructive biases in memory; Scharfe & Bartholomew, 1998) or concurrent associations between attachment and experiences. Relatively few studies are positioned to address these hypotheses in a prospective fashion.

Nonetheless, a small number of relevant longitudinal studies have begun to emerge in recent years. In one of the most rigorous studies to date, Dinero, Conger, Shaver, Widaman, and Larsen-

Rife (2008) examined the quality of observed interactions between adolescents and their parents in a sample of over 250 families. Dinero and her colleagues found that the quality of parent-child interactions at age 15 predicted self-reports of attachment security at age 25 (*r*s ranged from .05 to .21). This study is valuable because it provides some of the first longitudinal evidence that parent-child interactions are prospectively related to adult attachment styles. One limitation of the study, however, is that it did not address parent-child experiences prior to age 15, nor did it examine additional variables that are generally considered to play a role in shaping individual differences in adult attachment (e.g., peer relationships).

In another longitudinal study based on 35 people, Zayas, Mischel, Shoda, and Aber (2011) found a nonsignificant association ( $r = -.34$ ) between maternal caregiving assessed at 18 months of age and the extent to which the same participants held an avoidant attachment style age 22. In a subsample of 15 individuals, they found a statistically significant correlation ( $r = -.75$ ) between maternal caregiving assessed at 18 months of age and the extent to which the same participants were avoidant with respect to their romantic partners at age 22. One noteworthy feature of this study is that it examined the link between observations of early parenting and adult attachment across an expansive temporal interval (i.e., approximately 21 years). One limitation of the research, however, is that the small sample sizes place excessively wide error bands around the associations of interest.

In a larger study involving data from 1,070 individuals from the Young Finns Study, Salo, Jokela, Lehtimäki, and Keltikangas-Järvinen (2011) found that early maternal nurturance, assessed by maternal self-report when children were an average of 10 years old, significantly predicted children's avoidant attachment 21 to 27 years later ( $r = -.07$ ). This particular study is noteworthy largely due to the long time interval between assessments and the large sample size. Nonetheless, this research left several key hypotheses unexamined. For example, this research did not address the role of social competence, nor did it address the role of peer relationships or friendships in shaping attachment styles.

Taken together, these longitudinal studies suggest that there is a relatively small association between the quality of the parent-child relationship and adult attachment styles (approximately  $r = .10$ ). One drawback of these studies is that they are limited in the kinds of antecedents that were examined (i.e., they all focused exclusively on the quality of caregiving). Moreover, they did not attend to developmental issues in a way that is implied by attachment theory. Namely, according to Bowlby (1973), interpersonal experiences play a role in shaping personality *throughout* development. This implies not only that early caregiving experiences matter (as Bowlby clearly believed) but that experiences that take place across childhood and adolescence matter as well (Bowlby, 1973; Lewis, 1997). One of the goals of the present investigation was to examine a more diverse set of antecedents (i.e., the quality of the caregiving environment, social competence, and the quality of peer relationships) than has been previously examined and to do so across multiple developmental periods (e.g., early childhood, middle childhood, early adolescence).

## Temperamental and Genetic Antecedents of Adult Attachment Styles

Attachment researchers tend not to emphasize temperamental contributions to individual differences in adult attachment styles. Nonetheless, it is important to note that Bowlby (1973, p. 364) suggested that there may be preexisting temperamental differences in children and that attachment experiences serve to modulate, interact with, or potentially override these differences (see also Mangelsdorf, Gunnar, Kestenbaum, Lang, & Andreas, 1990). Thus, it is worthwhile to consider temperamental characteristics that might provide the foundation for individual differences in adult attachment.

It has been well established that self-report measures of adult attachment correlate with measures of heritable dispositional attributes, such as the Big Five personality traits. Attachment-related anxiety, for example, tends to correlate about .40 with Neuroticism (Nofle & Shaver, 2006). Moreover, attachment-related avoidance weakly to moderately correlates with Extraversion and Agreeableness. In a behavior genetic analysis of self-report measures of attachment and the Big Five personality traits, Donnellan, Burt, Levendosky, and Klump (2008) estimated that approximately 45% of the variation in attachment-related anxiety can be attributed to additive genetic variation and, moreover, that the correlation between attachment anxiety and Neuroticism can be accounted for almost entirely by additive sources of genetic variance that are common to those two constructs.

Taken together, these kinds of findings suggest three hypotheses about the antecedents of adult attachment. First, it might be the case that variation in attachment-related anxiety has antecedents in early observable temperamental variation (e.g., in the way in which negative affect is experienced and/or expressed). Second, it is possible that some of the variance in adult attachment styles might be explained by variation in specific genes that have been implicated in affective processes. Consistent with this possibility, in a sample of 147 undergraduates, Gillath, Shaver, Baek, and Chun (2008) reported that anxious attachment was associated with a polymorphism of the DRD2 dopamine receptor gene and that avoidant attachment was associated with a polymorphism of the HTR2A serotonin receptor gene (see Chen & Johnson, 2012, and Costa et al., 2009, for additional associations between genetic polymorphisms and adult attachment styles).

Finally, it might also be the case that genes and environments interact in ways that contribute to the development of adult attachment styles. Consistent with this possibility, Troisi et al. (2012) reported that variation in the  $\mu$ -opioid receptor gene (OPRM1) moderated the association between retrospective reports of early caregiving on fearfully avoidant attachment among adults. Salo et al. (2011) examined whether the HTR2A rs6313 single-nucleotide polymorphism (SNP) moderates the association between childhood maternal nurturance and adult attachment. They found that maternal nurturance predicted avoidant attachment in carriers of the T/T genotype, but not in carriers of the T/C or C/C genotype.

One of our goals in the present research was to examine these hypotheses concerning the temperamental and genetic correlates of adult attachment styles. Specifically, we examined the extent to which early assessments of temperament predicted adult attachment styles and whether we could replicate the full range of published findings (both main effects and Gene  $\times$  Environment

interactions) about molecular genetic involvement in the development of attachment-related avoidance and anxiety.

## Overview of the Present Research

In the present research, we sought to examine the interpersonal and genetic antecedents of adult attachment style using longitudinal data from the NICHD SECCYD. This sample provides a rare opportunity to examine some long-standing and foundational questions about the origins of adult attachment styles. Before describing the sample in detail, we elaborate briefly on three important points. First, in this report, we are focusing exclusively on adult attachment styles as they have been studied and assessed in social and personality psychology. There exists a separate literature on adult attachment that is rooted more explicitly in the developmental tradition that utilizes interview-based assessments of the coherence of peoples' discourse regarding early attachment experiences to assess security versus insecurity (see Roisman, 2009). We do not focus on the developmental tradition in the present report (but see Booth-LaForce & Roisman, 2012).

Second, although social psychologists have assessed adult attachment styles in a variety of ways over the years, most researchers currently conceptualize individual differences with respect to a variant of the two-dimensional model originally described by Bartholomew and Horowitz (1991; see Fraley & Shaver, 2008, for a detailed discussion). Specifically, one dimension, *attachment-related avoidance*, represents the extent to which individuals organize their attachment-related thoughts, feelings, and behaviors around defensive goals. Individuals who are high on this dimension are, for example, uncomfortable depending on others or having others depend on them. Individuals who are low on this dimension are comfortable using others as a safe haven and secure base and serving those functions for others. The other dimension, *attachment-related anxiety*, represents the extent to which individuals are concerned about the availability and responsiveness of close others. A prototypically secure person in this framework is low on both dimensions.

Third, contemporary theorists distinguish working models that are *global* (i.e., about interpersonal relationships in general) from those that are *domain specific* (i.e., about a specific relational context, such as parental relationships or romantic relationships; see Collins, Guichard, Ford, & Feeney, 2004; Overall, Fletcher, & Friesen, 2003). In the present research, we examine the antecedents of both global attachment styles and the attachment styles that people have regarding romantic relationships.

## Method

### Participants

Families were recruited for the NICHD SECCYD in 1991 from hospitals located near various research sites around the US; 1,364 families became study participants upon completing an interview when their infants were 1 month old. Details about recruitment and selection procedures are available in prior publications from the study (see NICHD Early Child Care Research Network, 2005). Participants were assessed longitudinally through age 15. In late adolescence (age 18), they were enrolled in a follow-up study focusing on adult attachment (see Booth-LaForce & Roisman,



2012). The analysis sample for this report included up to 707 participants from the age 18 follow-up who completed self-report measures of adult attachment style (52.3% female); 77.5% were White/non-Hispanic. Two hundred ninety individuals (41%) were involved in romantic relationships at age 18. Females were slightly more likely than males to report being involved in a relationship ( $\phi$  correlation = .09).

Of the initial 1,364 families in the SECCYD who were recruited shortly after the birth of their child, 707 of these study children completed at least one of the measures of attachment style at age 18. We compared demographic characteristics of the attachment style subsample ( $n = 707$ ) with those of the original SECCYD sample for whom we did not have attachment style data ( $n = 657$ ) and found that the attachment style subsample was significantly more likely to be female (52% vs. 44%),  $\chi^2(1, N = 1,364) = 9.50$ ,  $p = .002$ , but the groups did not differ by race/ethnicity (77.5% vs. 75.2% White/non-Hispanic vs. other),  $\chi^2(1, N = 1,364) = 0.02$ ,  $p = .31$ . The mothers in the attachment style subsample had significantly more years of education ( $M = 14.69$ ,  $SD = 2.42$ , vs.  $M = 13.74$ ,  $SD = 2.52$ ),  $t(1,361) = 7.13$ ,  $p < .001$ , as well as a higher income-to-needs ratio at birth ( $M = 3.14$ ,  $SD = 2.60$ , vs.  $M = 2.56$ ,  $SD = 2.60$ ),  $t(1,271) = 4.02$ ,  $p < .001$ .

## Measures

**Individual differences in attachment.** When the children were approximately 18 years of age, they participated in a web-based survey that included multiple self-report inventories, including two measures of adult attachment.

**Global attachment styles.** General attachment orientation was assessed with the Relationships Scales Questionnaire (RSQ; Griffin and Bartholomew, 1994). The RSQ is a multi-item inventory designed to assess the way in which people feel in close relationships. The RSQ was scored with respect to two dimensions: *attachment-related avoidance* and *attachment-related anxiety*. Composite scores for avoidance and anxiety were created using the Simpson, Rholes, and Nelligan (1992) scoring system, as described in detail by Roisman et al. (2007). The two dimensions correlated positively in the present sample ( $r = .49$ ) and had high reliabilities ( $\alpha = .81$  and  $.86$ , respectively).

**Romantic attachment styles.** The Experiences in Close Relationships-Revised (ECR-R; Fraley, Waller, & Brennan, 2000) was also administered. The ECR-R is designed to assess attachment orientation with respect to romantic relationships *in general*. It is not a global measure of attachment, nor was it used in this case to assess a *specific* romantic relationship. The ECR-R was also scored with respect to attachment-related avoidance and anxiety. The two dimensions correlated positively in the present sample ( $r = .33$ ) and had high reliabilities ( $\alpha = .94$  for both dimensions).

**Caregiving environment.** The quality of the caregiving environment was assessed in three ways: with respect to maternal sensitivity, maternal depression, and father absence.

**Maternal sensitivity.** Mother-child interactions were videotaped during 15-min semistructured tasks at 6 months, 15 months, 24 months, 36 months, 54 months, Grade 1, Grade 3, Grade 5, and age 15. At each assessment point, the study children were videotaped while engaging in tasks at the zone of proximal development while primary caregivers provided assistance at the younger ages; at older ages, joint tasks, including discussion tasks, were used.

Tasks were designed to be developmentally appropriate. For example, the 54-month and Grade 1 assessments involved the child completing a set of three activities with the mother, including using an Etch-a-Sketch to traverse a maze (54 months) and reproduce a simple picture (Grade 1). During Grades 3 and 5, primary caregivers and target participants completed joint activities as well as engaging in discussion tasks. Finally, at age 15, maternal sensitivity was assessed in the context of an 8-min home discussion of one or two areas of disagreement between the adolescent and mother (e.g., chores, homework). More information on the tasks, the scoring system, and the reliabilities in the full sample can be found in Belsky et al. (2007); NICHD Early Child Care Research Network (2001, 2004, 2008); Roisman, Booth-LaForce, Cauffman, Spieker, & the NICHD Early Child Care Research Network (2009); and Roisman, Susman, et al. (2009).

**Maternal depression.** Maternal depression was assessed using the Center for Epidemiological Studies Depression (CES-D) scales. The CES-D scales were administered to mothers at the following assessment waves: 1 month, 6 month, 15 month, 24 month, 36 month, 54 month, Grade 1, Grade 3, Grade 5, Grade 6, and age 15. Alphas ranged from .88 to .91 ( $M = .90$ ).

**Father absence.** At each of 27 waves from 1 month through age 15, an assessment was made of whether the child's father was living in the household. For the purposes of this report, we created a single binary variable that represented whether the child's father was continuously present in the household (65%) or absent at any point (35%). This binary variable correlated  $r = .85$  with a continuous measure of the proportion of time the father was absent.

**Social competence.** Mothers completed the 38-item Social Skills Questionnaire (SSQ) from the Social Skills Rating System (SSRS; Gresham & Elliott, 1990) when children were age 54 months; in kindergarten, Grades 1, 3, 4, 5, and 6; and at age 15, indexing general social competence with adults and other children. To obtain a standardized measure of total social skills, an a priori scale was created by summing all items that index social competence with other children, with higher scores indicating more socially skilled children ( $\alpha$ s ranged from .87 to .91;  $M = .89$ ).

We also examined teacher reports of children's social competence. In a parallel fashion, teachers completed the 30-item school version of the SSQ from the SSRS when children were in kindergarten as well as Grades 1, 2, 3, 4, 5, and 6. As with the mother reports, a standardized total social skills scale was created at each assessment wave by summing items indexing social competence ( $\alpha$ s ranged from .93 to .94;  $M = .94$ ).

**Friendship quality.** Children's perceptions of friendship quality with their self-identified best friend were assessed via the Friendship Quality Questionnaire (FQQ; Parker & Asher, 1993) in Grades 3, 4, 5, and 6 and at age 15. At all ages, the same 21 FQQ items were used. At Grade 6 and age 15, additional items were added that were developmentally appropriate, but these items were not included in the analysis. The FQQ uses a 5-point response scale to measure six qualitative aspects of the friendship: validation and caring, conflict resolution, conflict and betrayal (reversed), help and guidance, companionship and recreation, and intimate exchange. The questionnaire yields a total score indicating the quality of the best friendship ( $\alpha$ s ranged from .87 to .93;  $M = .90$ ).

**Early temperament (54 months).** Early temperament was assessed at 54 months using the Children's Behavior Questionnaire (CBQ; Rothbart, Ahadi, Hershey, & Fisher, 2001). Mothers rated their children with respect to 80 of the 196 CBQ items. Following the procedures used by Fraley, Griffin, Belsky, and Roisman (2012), we used empirically derived temperament dimensions by factor analyzing the item-level data and rotating the factors to varimax criteria. After studying solutions ranging from three to six factors, we extracted five factors (all with eigenvalues  $> 2$ ) to best balance parsimony and content coverage. Composites for each factor were created by averaging responses to items loading .40 or higher on each factor. The first factor, which we labeled *Restlessness/Activity* ( $\alpha = .85$ ), was indicated by items such as "has difficulty waiting in line" and "tends to run rather than walk from room." The second factor, which we labeled *Shyness* ( $\alpha = .87$ ), was indicated by items such as "acts shy around new people." The third factor, which we labeled *Attentional Focusing* ( $\alpha = .80$ ), was indicated by items such as "is good at following directions" and "moves from one task to the other without completion" (reversed). The fourth factor, which we labeled *Passivity* ( $\alpha = .55$ ), was indicated by items such as "rarely protests if another child takes toy." The fifth factor, which we labeled *Fear* ( $\alpha = .68$ ), was indicated by items such as "is afraid of the dark" and "rarely upset when watching a sad TV event" (reversed). Because the reliability for the Passivity scale was low, we focused our analyses on the other four dimensions.

**Genotyping.** Genetic data were available for a subsample of up to 503 participants who also completed at least one of the attachment style measures. DNA extraction and genotyping for the NICHD SECCYD was performed at the Genome Core Facility in the Huck Institutes for Life Sciences at Penn State University under the direction of Deborah S. Grove, Director for Genetic Analysis. For this analysis, we examined the entire set of polymorphisms that have been studied in relation to adult attachment styles in previous reports: OXTR rs53576 (A risk, G nonrisk; Chen & Johnson, 2012; Costa et al., 2009; Gillath et al., 2008), OXTR rs2254298 (A risk, G nonrisk; Chen & Johnson, 2012; Costa et al., 2009), DRD2 rs1800497 (A1+ or T allele risk, A1- or C allele nonrisk; Gillath et al., 2008), HTR2A rs6313 (T risk, C nonrisk; Gillath et al., 2008; Salo et al., 2011), and OPRM1 rs1799971 (A risk, G nonrisk; Troisi et al., 2012). Frequency distributions for the SNPs did not depart significantly from the Hardy-Weinberg equilibrium, except HTR2A rs6313 ( $\chi^2 = 7.7, p < .001$ ) and OPRM1 rs1799971 ( $\chi^2 = 17.7, p < .001$ ). Extraction and genotyping information is available in the online supplemental materials.

In this subsample, reliability was ascertained by genotyping  $n = 55$  samples twice ( $\sim 11\%$  of  $N = 503$ ), with discrepancies resolved via a third genotyping. For OXTR rs53576, 3% of available samples could not be genotyped in the available subsample ( $N = 503$ ), and  $\kappa_{\text{additive}} = .87$  and  $\kappa_{\text{dominance}} = .89, ps < .001, 93\%$  and 95% agreement, respectively. For OXTR rs2254298 and DRD2 rs1800497, 1% of available samples could not be genotyped in the available subsample, and there was 100% agreement (i.e.,  $\kappa_{\text{additive}} = 1.0$  and  $\kappa_{\text{dominance}} = 1.0, ps < .001$ ) for both SNPs. For HTR2A rs6313, 5% of available samples could not be genotyped, and  $\kappa_{\text{additive}} = .94$  and  $\kappa_{\text{dominance}} = .94, ps < .001, 96\%$  and 98% agreement, respectively. Finally, for OPRM1 rs1799971, 9% of available samples could not be genotyped, and  $\kappa_{\text{additive}}$  and  $\kappa_{\text{dominance}} = .92, ps < .001, 96\%$  agreement for additive

and dominance reliability. (Note that because HTR2A rs6313 and OPRM1 rs1799971 were assayed during a second round of genotyping, there was an additional set of cases in the  $N = 503$  subsample that were by that time unusable and for which genotyping on these SNPs was not attempted;  $n = 28, \sim 6\%$ ).

**Control variables.** Although there are a large number of potential control variables to consider, we selected four that we have examined in previous research based on the SECCYD (e.g., Roisman, Booth-LaForce, et al., 2009; Roisman, Susman, et al., 2009) and which are known to correlate with many of the antecedent variables examined in this report: child gender, child ethnicity, maternal education, and family income. Child gender was coded in a binary fashion (0 = female, 1 = male). Because the majority of the children in the sample were White/non-Hispanic, we created a binary variable to represent ethnicity (1 = White/non-Hispanic, 0 otherwise). Maternal education was coded on an ordered metric representing the number of years of education/highest degree. Family income was operationalized as an income-to-needs ratio. Income-to-needs was computed separately within each of 12 assessment waves (1 month to age 15), standardized within wave, and averaged across waves to create a composite family income index. The composite was log-transformed to reduce skew.

## Results

We organize the results across three sections. In the first section, we examine the associations between various developmental antecedents and adult attachment styles. As is explained more fully, these analyses were based on latent growth curve models so that we could study the influence of early experiences in addition to changes in experiences over the course of childhood and adolescence. In the second section, we examine the various antecedents of attachment style in a multiple regression framework in which we simultaneously controlled the covariates (e.g., sex, ethnicity) and the shared covariation among antecedents. This allowed us to estimate the unique contribution of various factors to adult attachment styles. In the final section, we focus on temperament and attempt to replicate previous findings regarding the contribution of genetic variation and potential Gene  $\times$  Environment interactions in adult attachment styles.

### Associations Between Developmental Antecedents and Adult Attachment

To examine the associations between developmental antecedents and adult attachment styles, we estimated the parameters of a series of latent growth curve models. The structure of the general model that was used is illustrated in Figure 1. In short, for each predictor variable (e.g., maternal sensitivity), we modeled the observed scores as a function of two latent variables: (a) intercepts and (b) slopes. Using maternal sensitivity as an example, the latent intercept represents the estimated maternal sensitivity a child received in early childhood (i.e., the value of sensitivity at the first assessment wave, but estimated on the basis of the full array of observations rather than the first wave of observations alone). As such, variation in these intercepts across people represents individual differences in the quality of people's early caregiving environments. The latent slope represents the extent to which the

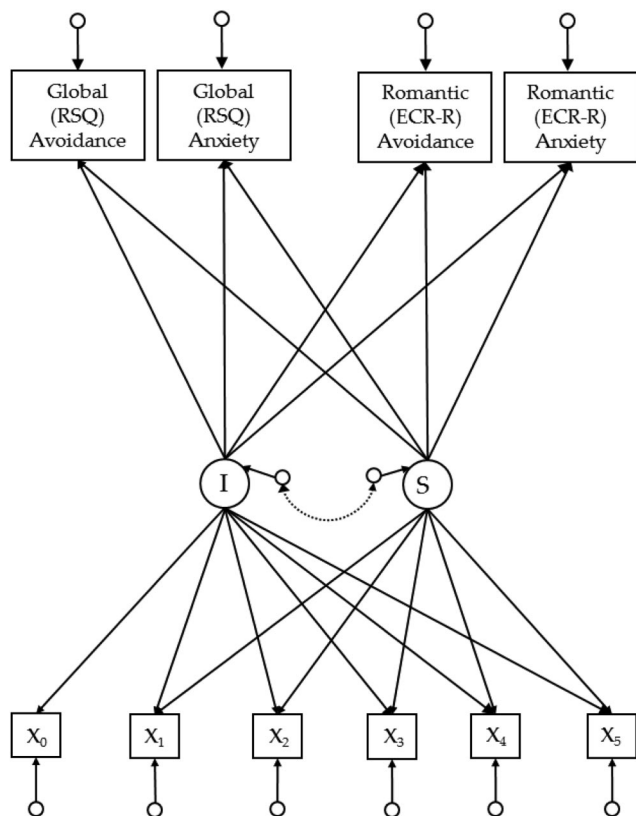


Figure 1. An illustration of the growth curve model used to model the relationships between developmental experiences and adult attachment style. I represents variation in intercepts (starting values) across people. S represents variation in the linear slopes across people. X represents measurements of the developmental variable of interest (e.g., maternal sensitivity, maternal depression). The paths from I to the measured variables,  $X_t$ , were set to 1 for the purposes of identification. The paths from S to  $X_t$  were set to (0, 1, 2, . . .) to represent linear change in  $X_t$  across time. ECR-R = Experiences in Close Relationships–Revised; RSQ = Relationships Scales Questionnaire.

quality of care a person received increased or decreased linearly across assessment waves.<sup>1</sup> The self-report measures of adult attachment were regressed onto the latent intercepts and slopes simultaneously (see Figure 1).

It is important to note that we standardized the scores across people within each assessment wave. We did so because the scores within each assessment are not assumed to have the same absolute interpretation given that some of the tasks and measures are designed to be developmentally appropriate at each assessment period. As a result of this standardization, a person’s latent slope estimate does not represent his or her *absolute* change over time. Instead, it represents his or her change *relative to others*. A person with a positive slope, for example, increased over time in his or her rank ordering relative to other people. A person with a negative slope, in contrast, decreased over time in his or her rank ordering.<sup>2</sup>

There are at least two advantages to using a latent growth framework for studying the associations between developmental antecedents and adult attachment. First, doing so allows us to study antecedents in a way that recognizes that people differ from one

another not only in the quality of their early experiences but also in the way those experiences evolve over time. This is critical from an attachment-theoretical perspective because it is assumed that *changes* in the caregiving environment should also be reflected in a person’s attachment orientation (e.g., Mikulincer & Shaver, 2007). The second advantage of this framework is that it models, or statistically controls, the covariation between intercepts and slopes in estimating the relations between these factors and adult attachment. That is, it takes into consideration the possibility that intercepts and slopes are likely to be correlated across people (i.e., people who start low are more likely to experience increases over time than decreases).

The results of the latent growth curve analyses are presented in Table 1. It should be noted that all of the antecedent variables of interest were time varying, except for father absence. In the analyses of father absence, we simply report the regression of attachment styles onto that single predictor.

**Global attachment-related avoidance (RSQ avoidance).** The various measures of individuals’ caregiving environments predicted global avoidance at age 18. For example, individuals who experienced high levels of maternal sensitivity early in life tended to be less avoidant at age 18 ( $\beta = -.16$ ). Moreover, individuals who experienced increases in maternal sensitivity over time relative to others tended to be less avoidant at age 18 ( $\beta = -.20$ ). Participants were more avoidant at age 18 if their mothers reported relatively high levels of depression initially ( $\beta = .12$ ) or if their mothers reported increases in depressive symptoms over time relative to others ( $\beta = .14$ ). Individuals who did not consistently live in the same household as their fathers were more likely to be avoidant ( $r = .17$ ).

Mother and teacher reports of social competence also predicted global attachment-related avoidance at age 18. Individuals were less avoidant at age 18 if they were judged as more socially competent early in life ( $\beta = -.20$  for mother ratings and  $\beta = -.32$  for teacher ratings) or if they exhibited increases in competence over time ( $\beta = -.11$  for mother ratings and  $\beta = -.39$  for teacher ratings). Finally, best friendship quality predicted attachment-related avoidance. Individuals who had a high-quality best friendship early in childhood ( $\beta = -.13$ ) or who experienced a best friendship of increasingly higher quality over time relative to others ( $\beta = -.30$ ) were less likely to be avoidant.

**Global attachment-related anxiety (RSQ anxiety).** It is important to note that the estimates of the associations between the quality of caregiving experiences and general attachment-related

<sup>1</sup> We focused on linear models of change for two reasons. First, attachment theory is primarily concerned with the relative quality of people’s early experiences and whether the quality of those experiences increases, decreases, or stays the same over time. A simple linear model captures these expectations in a parsimonious way. Second, although the introduction of additional terms (e.g., quadratic) has the potential to allow individual trajectories to be modeled with more precision, the addition of an additional parameter carries the cost of increasing the complexity of the analyses considerably without the benefit of allowing additional hypotheses that can be generated a priori from the theory to be tested.

<sup>2</sup> Some of the predictor variables (e.g., maternal depression) did use the same response scale across repeated assessments. In the interest of presenting the results in a uniform manner for various antecedents, we standardized these variables within assessment wave too. Standardizing within waves versus not standardizing within waves had no impact on the pattern of findings reported here.



Table 1  
*Associations Between Adult Attachment Styles and Intercepts and Slopes of Developmental Antecedents*

Predictor	Outcome	I → outcome	S → outcome	
Caregiving environment Maternal sensitivity	Global avoidance	<b>-.16</b>	<b>-.20</b>	
	Global anxiety	-.08	-.12	
	Romantic avoidance	-.03	<b>-.15</b>	
	Romantic anxiety	.07	-.04	
Maternal depression	Global avoidance	<b>.12</b>	<b>.14</b>	
	Global anxiety	<b>.10</b>	<b>.17</b>	
	Romantic avoidance	.04	.11	
	Romantic anxiety	-.01	<b>.18</b>	
Father absence	Global avoidance	<b>.17</b>		
	Global anxiety	<b>.08</b>		
	Romantic avoidance	.03		
	Romantic anxiety	-.01		
Social competence Social competence (mother rated)	Global avoidance	<b>-.20</b>	<b>-.11</b>	
	Global anxiety	<b>-.09</b>	<b>-.16</b>	
	Romantic avoidance	<b>-.09</b>	-.05	
	Romantic anxiety	-.01	<b>-.10</b>	
	Social competence (teacher rated)	Global avoidance	<b>-.32</b>	<b>-.39</b>
		Global anxiety	<b>-.20</b>	<b>-.23</b>
		Romantic avoidance	<b>-.21</b>	<b>-.37</b>
		Romantic anxiety	-.03	<b>-.17</b>
Friendship quality	Global avoidance	<b>-.13</b>	<b>-.30</b>	
	Global anxiety	<b>-.11</b>	<b>-.15</b>	
	Romantic avoidance	<b>-.19</b>	<b>-.31</b>	
	Romantic anxiety	-.04	-.02	

*Note.* Boldface is used to highlight statistically significant predictors. Regression coefficients are standardized. I → outcome = regression of outcome on intercepts of the predictor; S → outcome = regression of outcome on slopes of the predictor.

anxiety were in the same direction but were generally weaker and not always statistically significant. Maternal sensitivity, for example, was not significantly related to attachment-related anxiety ( $\beta = -.08$  and  $-.12$  for intercepts and slopes, respectively), although father absence ( $r = .08$ ), early levels of maternal depression ( $\beta = .10$ ), and changes in maternal depression ( $\beta = .17$ ) significantly predicted general anxiety. Both early levels and changes in social competence and best friendship quality were related to attachment-related anxiety. Specifically, people were more anxious with respect to attachment at age 18 if they had a relatively poor-quality best friendship earlier in life or increasingly deteriorating best friendship quality over time relative to other people.

**Romantic attachment-related avoidance (ECR-R avoidance).** For the most part, measures of early caregiving experiences were not related to romantic avoidance (as measured by the ECR-R), the exception being that individuals who experienced increases in maternal sensitivity over time were less likely to report avoidance in romantic relationships ( $\beta = -.15$ ). Social competence was not uniformly related to romantic attachment avoidance. Although teacher ratings of competence were related to lower levels of romantic avoidance (both intercepts and slopes), only the intercepts for maternal ratings of competence were related to avoidance. Friendship quality did predict romantic avoidance. Specifically, individuals who had a higher quality best friendship

earlier in life ( $\beta = -.19$ ) or who had an improving best friend relationship ( $\beta = -.15$ ) were less likely to report romantic attachment-related avoidance at age 18.

**Romantic attachment-related anxiety (ECR-R anxiety).** Although increases in social competence, as rated by parents and teachers, predicted lower levels of romantic anxiety at age 18, the broader picture is that attachment anxiety had relatively few antecedents and, to the extent to which it did, those antecedents were limited to slopes (i.e., changes in various predictors) rather than intercepts (i.e., estimates of early levels of those predictors).

### Multiple Regression Analyses

Using the estimates of the individual-level intercepts and slopes from the previous analyses, we conducted follow-up regression analyses in which we examined the relative contributions of various antecedents while controlling for their shared covariation and covariates that are known to be related to those antecedents. We also statistically controlled attachment-related anxiety when modeling the antecedents of attachment-related avoidance and vice versa. This was done because the two attachment dimensions are moderately correlated with one another, using both the RSQ and the ECR-R, and we were interested in probing the unique origins of variation in each attachment dimension. To conserve space, we also combined the mother and teacher ratings of social competence

given that these ratings were positively correlated and the findings for each source were similar when examined separately.

We do not discuss the estimated parameters for the covariates per se in each section below, so we note here that, in general, the covariates did not predict the ECR-R or RSQ attachment dimensions, with the exception of ethnicity, which was related to both global and romantic avoidance. Consistent with other findings (e.g., Mickelson et al., 1997), White/non-Hispanic participants tended to be lower in attachment-related avoidance than others. Also, as expected, the contemporaneously assessed attachment dimensions predicted one another (e.g., global anxiety was significantly related to global avoidance). Because the contemporaneous attachment covariates were not developmental antecedents per se, we report  $R^2$ s in the tables from models that both include and exclude this covariate. (The correlations among all variables examined are reported in the online supplemental materials.)

**Global attachment-related avoidance (RSQ avoidance).** As shown in Table 2, participants who experienced greater maternal sensitivity over time were less avoidant at age 18 ( $\beta = -.12$ ). In addition, individuals who did not live consistently with their fathers were more likely to be avoidant than those who did ( $\beta = .08$ ). Early levels and changes in maternal depression did not significantly predict variation in avoidance once the other factors were controlled.

Individuals who exhibited social competence early in childhood ( $\beta = -.11$ ) or who exhibited increasing levels of social competence ( $\beta = -.11$ ) were less likely to be avoidant at age 18. Finally, individuals who had a high-quality best friendship in early childhood ( $\beta = -.09$ ) or who experienced an increasingly high-quality best friendship over time ( $\beta = -.33$ ) were less likely to be avoidant at age 18.

**Global attachment-related anxiety (RSQ anxiety).** Results shown in Table 3 indicated that individuals whose mothers reported

increasing levels of depressive symptoms over time were more likely to report attachment-related anxiety at age 18 ( $\beta = .12$ ). Increases in social competence over time also predicted lower ratings of anxiety at age 18 ( $\beta = -.12$ ). Friendship variables, however, were not related to anxiety once avoidance was controlled.

**Romantic attachment-related avoidance (ECR-R avoidance).** The findings for romantic attachment-related avoidance (see Table 4) were similar to those for global avoidance summarized above. Individuals who were relatively avoidant with respect to attachment concerns at age 18 were (a) more likely to have experienced decreases in parental sensitivity over time ( $\beta = -.12$ ), (b) more likely to have experienced decreases in social competence over time ( $\beta = -.11$ ), and (c) less likely to have experienced high-quality friendships in early childhood ( $\beta = -.18$ ) and to have experienced increasingly low-quality friendships over time ( $\beta = -.41$ ).

**Romantic attachment-related anxiety (ECR-R anxiety).** As shown in Table 5, individuals who were relatively anxious with respect to attachment were (a) more likely to have mothers who reported more depressive symptoms over time ( $\beta = .20$ ), (b) less likely to increase in social competence over time ( $\beta = -.19$ ), and (c) were *more* likely to have friendships that increased in quality over time ( $\beta = .18$ ). This later finding is inconsistent with adult attachment theory.

**Summary.** In summary, once we controlled for some potential confounding variables and took into consideration the mutual covariation among predictors, we found that variation in global attachment avoidance at age 18 was a function of variation in the caregiving environment, social competence, and the quality of friendships. Importantly, in these analyses, it appeared that variation in the quality of the early caregiving environment per se was less relevant than variation in relative changes in the caregiving environment over time.

Table 2  
Global Avoidance (Relationships Scales Questionnaire Avoidance) as a Function of Covariates and Developmental Antecedents

Predictor	<i>B</i>	<i>SE</i>	$\beta$	<i>p</i>
Covariates				
Gender	<b>-.11</b>	<b>.04</b>	<b>-.08</b>	<b>.01</b>
Ethnicity	<b>-.12</b>	<b>.05</b>	<b>-.07</b>	<b>.03</b>
Maternal education	.02	.01	.07	.05
Family income	.10	.08	.05	.19
Global anxiety	<b>.30</b>	<b>.03</b>	<b>.37</b>	<b>&lt;.01</b>
Caregiving environment				
Sensitivity (intercept)	-.03	.03	-.05	.25
Sensitivity (slope)	<b>-.08</b>	<b>.02</b>	<b>-.12</b>	<b>&lt;.01</b>
Maternal depression (intercept)	.00	.02	.00	.98
Maternal depression (slope)	.01	.02	.02	.59
Father absence	<b>.11</b>	<b>.05</b>	<b>.08</b>	<b>.02</b>
Social competence				
Social competence (intercept)	<b>-.09</b>	<b>.03</b>	<b>-.11</b>	<b>.01</b>
Social competence (slope)	<b>-.10</b>	<b>.03</b>	<b>-.11</b>	<b>.01</b>
Friendship quality				
Friendship quality (intercept)	<b>-.06</b>	<b>.02</b>	<b>-.09</b>	<b>.01</b>
Friendship quality (slope)	<b>-.23</b>	<b>.02</b>	<b>-.33</b>	<b>&lt;.01</b>

*Note.* The intercept for the model was 1.55. The  $R^2$  of the model was .41,  $F(14, 691) = 34.45, p < .05$ . The  $R^2$  of the same model, excluding attachment-related anxiety as a covariate, was .29. Boldface is used to highlight statistically significant predictors. Gender was coded as 0 for female and 1 for male. Ethnicity was coded as 1 for White/non-Hispanic and 0 otherwise.

Interestingly, although the various antecedents were associated with the attachment dimensions, they predicted those dimensions in distinct ways. Namely, avoidance was largely a function of changes in maternal sensitivity, social competence, and the quality of friendship relationships, but not maternal depression. Attachment-related anxiety, in contrast, had antecedents in maternal depression and social competence, but not maternal sensitivity or best friendship quality.<sup>3</sup>

Taken together, these findings are largely consistent with the implications of adult attachment theory.<sup>4</sup> There was at least one crucial exception, however. Namely, we found that individuals who had a best friendship of increasingly high quality over time were more likely at age 18 to report relatively higher levels of romantic anxiety. We return to this finding in the General Discussion.

### Temperamental and Genetic Antecedents and Gene $\times$ Environment Interactions

**Temperament analyses.** We next examined potential temperamental and genetic antecedents of adult attachment styles. We first examined the zero-order correlations between the four major temperament dimensions (i.e., shyness, activity, fear, and attentional focus) and the global and romantic attachment dimensions. The only two significant correlations were between restlessness and global anxiety ( $r = .12$ ) and restlessness and global avoidance ( $r = .11$ ). In short, individuals who were more globally insecure were more likely to have been rated as restless and irritable at 54 months of age.

We also examined the association between the attachment dimensions and the temperamental dimensions in a regression framework, controlling for the same covariates discussed previously and the shared covariation among the temperamental dimensions. The results of these analyses are summarized in Tables 6, 7, 8, and 9. In short, once we controlled for various factors simultaneously, there were no statistically significant temperamental antecedents of adult attachment styles.<sup>5</sup>

**Genetic analyses.** There are a large number of potential SNPs and variable number tandem repeats that can be examined in the SECCYD. Thus, to narrow the scope of our investigation, we chose to focus specifically on genetic polymorphisms that other investigators have studied in the literature on the molecular genetics of attachment style.

Table 10 summarizes the key findings that have been reported previously along with a summary of our analyses that targeted the same polymorphisms. In each analysis, we modeled variation in the attachment dimensions of interest as a linear function of (a) ethnicity (to control for potential ethnic stratification artifacts) and (b) the genotypes in question. We used the RSQ measure of attachment as the outcome variable in situations in which previous investigators used a global attachment measure (e.g., the Relationships Questionnaire by Bartholomew & Horowitz, 1991) and the ECR-R when investigators had used a romantic attachment measure (e.g., the ECR by Brennan, Clark, & Shaver, 1998).

In short, we were unable to replicate any of the genetic main effects that have been reported previously in the literature, with one exception. Namely, we found that individuals who were homozygous with respect to the C allele of the HTR2A (rs6313) serotonin receptor gene had higher global attachment-related anx-

ety scores than did individuals who were TT or TC. This is consistent with data reported by Salo et al. (2011), who found that attachment-related anxiety was higher among CC carriers than TT or TC carriers. We did not find an association between DRD2 A1 and attachment anxiety, but we should note that the number of people classified as TT was relatively small ( $n = 20$ ), potentially undermining the power of this analysis.

We also attempted to replicate two Gene  $\times$  Environment interactions that have been reported in the literature. In a sample of 112 psychiatric patients, Troisi et al. (2012) found that variation in the  $\mu$ -opioid receptor gene moderated the influence of early sensitivity on fearful attachment. We tested this by modeling both attachment-related anxiety and avoidance, separately, as a linear function of (a) ethnicity, (b) genotype, (c) maternal sensitivity intercepts, (d) maternal sensitivity slopes, (e) the interaction between maternal sensitivity intercepts and genotype, and (f) the interaction between maternal sensitivity slopes and genotype. Fol-

<sup>3</sup> The NICHD SECCYD also contains data from the Strange Situation, which was administered when the children were 15 months of age. We have not included Strange Situation measures in the primary analyses because, theoretically, Strange Situation behavior is a marker of the quality of the caregiving environment, which is measured in multiple ways in the SECCYD. Nonetheless, we realize that the association between early attachment in the Strange Situation and adult attachment styles is of interest for the purposes of understanding continuity and change in attachment organization. Results of analyses involving the Strange Situation are contained in the online supplemental materials. To summarize those results briefly: Children who were relatively secure with respect to proximity-seeking behavior in the Strange Situation (Fraley & Spieker, 2003) were less likely to report global or romantic anxiety at age 18 ( $\beta_s = -.09$ ). There was no association between the infant attachment dimensions and global or romantic avoidance at age 18.

<sup>4</sup> We have focused on the antecedents of adult attachment style using a main-effects model largely because we believe that the core assumptions of the theory are best articulated as main effects. However, there are a number of mediational pathways that can be derived from attachment theory as well. Thus, as auxiliary analyses, we examined two possibilities that were suggested by reviewers. The first model assumes that early sensitivity leads to social competence, which, in turn, leads to higher friendship quality, which, in turn, leads to lower levels of anxiety and avoidance. The second model assumes that caregiving sensitivity may affect variation in both social competence and friendship quality, both of which may serve as mediators of the association between early caregiving and adult attachment styles. To examine these models, we rescaled the time parameters in our growth models such that the intercepts for sensitivity were located at the first assessment (i.e., 6 months), time for mother ratings of social competence was centered at Grade 1, and time for friendship quality was centered at age 15 years. (These particular time choices were arbitrary but do not affect the general pattern of results that we summarize below.) With respect to the first model, we found that although early sensitivity predicted mother ratings of social competence, variation in mother ratings of social competence did not predict variation in friendship quality at age 15. Thus, the data are not compatible with the mediational process in question. With respect to the second model, again, the mediation chain broke down with friendship quality. In short, early sensitivity did not predict friendship quality at age 15 years. We should be clear that these analyses do not suggest that early sensitivity is unrelated to friendship quality more generally. For example, early sensitivity correlates with increases (i.e., slopes) in friendship quality over time. It is possible that alternative formalizations of the mediational pathways may lead to different conclusions.

<sup>5</sup> We also examined an additional measure of temperament that is available in the SECCYD: a mother report of the child's difficult temperament, assessed when the child was 1 month and 6 months of age (see Pluess & Belsky, 2009, for more information). This composite did not correlate significantly with any of the attachment dimensions ( $r_s$  ranged from  $-.03$  to  $.05$ ).

lowing Troisi and colleagues, we used a dominance model for genotyping and contrasted individuals who were homozygous with respect to the A allele and those who were heterozygous (GG or AG). We were unable to replicate the findings reported by Troisi et al. Specifically, there were no interactions with maternal sensitivity (intercepts or slopes) and variation in OPRM1 in predicting variation in anxiety or avoidance.

Salo et al. (2011) found an interaction between variation in HTR2A and maternal nurturance such that individuals who carried two T alleles of the HTR2A rs6313 SNP exhibited a stronger inverse relation between maternal nurturance and avoidant attachment. We tested this by modeling global attachment-related avoidance as a linear function of (a) ethnicity, (b) genotype, (c) maternal sensitivity intercepts, (d) maternal sensitivity slopes, (e) the interaction between maternal sensitivity intercepts and genotype, and (f) the interaction between maternal sensitivity slopes and genotype. We found that variation in the HTR2A gene interacted with *changes* (i.e., slopes) in maternal caregiving over time to predict global attachment-related avoidance. Specifically, individuals who carried two T alleles exhibited a stronger inverse association between increases in maternal caregiving over time and avoidance than did C allele carriers (TC or CC). The interaction is plotted in Figure 2.

To summarize, we did not find robust evidence for genetic antecedents of adult attachment styles, despite examining the entire set of polymorphisms reflected in the literature on the molecular genetic correlates of self-reported attachment style and using a sample size that was approximately four times as large as a typical study on such issues. We were, however, able to partially replicate the findings of Salo et al. (2011). Namely, we found that attachment-related anxiety was higher among CC carriers than TT or TC carriers of the HTR2A (rs6313) gene. Moreover, we found evidence of a Gene  $\times$  Environment interaction that partially replicates one reported by Salo et al. The negative association between increases in maternal sensitivity and avoidant attachment was strongest among individuals who were homozygous for the T allele with respect to the serotonin HTR2A gene.<sup>6</sup>

## General Discussion

The objective of this research was to examine the interpersonal and genetic antecedents of individual differences in adult attachment styles. To do so, we examined data from an age 18 follow-up of the SECCYD, one of the largest longitudinal studies of human development to date and one that contains a rich array of variables relevant to social development. We used these data to examine three kinds of developmental factors that attachment theorists have hypothesized give rise to variation in adult attachment styles: (a) maternal sensitivity and other factors that contribute to the quality of the caregiving environment, (b) the individual's emerging social competence, and (c) the quality of the individual's best friendship. We also examined some potential origins of individual differences in adult attachment that are less commonly studied by attachment theorists, including temperament and genetic variation that has been implicated in the functioning of several affective systems (e.g., dopaminergic, serotonergic, and oxytonergic).

In summary, individual differences in attachment style were correlated with a wide array of developmental antecedents, including early maternal sensitivity, changes in maternal sensitivity, father ab-

sence, early and changing social competence, and best friendship quality. When we statistically controlled the shared covariation among various antecedents, we found that attachment-related avoidance was significantly predicted by changes in sensitivity, social competence, and friendship quality, whereas attachment-related anxiety was associated with changes in social competence and maternal depression. We did not find robust evidence for temperamental or genetic antecedents of adult attachment, but we were able to replicate two findings regarding the role of HTR2A in adult attachment.

These findings are broadly consistent with the developmental assumptions that have been made by social psychologists who study attachment processes in adulthood. Moreover, they help fill an empirical gap that has existed in the social psychological literature for over 25 years. Nonetheless, we believe there are some caveats that should be kept in mind when interpreting these findings and considering their implications for adult attachment theory.

<sup>6</sup> In an effort to be cautiously comprehensive, we conducted a series of regressions in which each of the four attachment variables were modeled as a function of (a) ethnicity, (b) maternal sensitivity (both intercepts and slopes), (c) genetic variation, and (d) the interaction between genetic variation and sensitivity (with separate interaction terms for Gene  $\times$  Environmental Intercepts and Gene  $\times$  Environmental Slopes). We conducted these analyses for both additive models of genetic variance (i.e., operationalizations in which the cumulative number of risk alleles are quantitatively ordered) and dominance models. Dominance analyses were conducted by grouping carriers of the risk allele (whether heterozygous or homozygous) and contrasting them with individuals who did not carry the allele. The exceptions were for the HTR2A rs6313 and OPRM1 rs1799971 SNPs, in which we demarcated risk in relation to being homozygous for T (TT; compared to a CC or CT) for HTR2A rs6313 and homozygous for A (AA; compared to AG or GG) for OPRM1 rs1799971 as in Salo et al. (2011) and Troisi et al. (2012), respectively. Thus, a total of 80 interactions were tested (i.e., 4 attachment dimensions  $\times$  5 polymorphisms  $\times$  2 codings of the polymorphisms [i.e., additive vs. dominance]  $\times$  2 interactions [Gene  $\times$  Environmental Intercept, Gene  $\times$  Environmental Slope]). Using an alpha threshold of .05, only four (i.e., 5%) interactions were statistically significant, which is the expected value if there are no interactions between the genes tested and the environmental constructs studied. These four include the one that replicated Salo et al. In addition, a reviewer suggested that there may be alternative Gene  $\times$  Environment pathways operating that have not been examined in the literature to date. For example, it is possible that early sensitivity interacts with specific genes to affect social competence or friendship quality and that those factors (either alone or in combination with other Gene  $\times$  Environment interactions) lead to variation in attachment style. We examined this possibility in an exploratory manner. To do so, we conducted a series of regression analyses in which we examined the interaction between each of the five genotypes previously highlighted and the intercepts and slopes of sensitivity in predicting both (a) intercepts and slopes for social competence and (b) intercepts and slopes for friendship quality. Specifically, we estimated the parameters of the following regression model for each possible combination of outcomes and predictors:  $\text{outcome} = \text{constant} + \text{ethnicity} + \text{sensitivity intercepts} + \text{sensitivity slopes} + \text{gene} + (\text{Sensitivity Intercepts} \times \text{Gene}) + (\text{Sensitivity Slopes} \times \text{Gene}) + \text{error}$ . We examined both additive and dominance models. Thus, in total, we conducted a total of 80 interaction tests: 5 genes  $\times$  2 genetic models (additive and dominance)  $\times$  2 Gene  $\times$  Environment interaction types (i.e., Gene  $\times$  Sensitivity Intercepts and Gene  $\times$  Sensitivity Slopes)  $\times$  4 outcomes (i.e., social competence intercepts, social competence slopes, friendship quality intercepts, friendship quality slopes). Out of these 80 Gene  $\times$  Environment tests, four were statistically significant at the .05 level. Because this hit rate (5%) is identical to the alpha rate, we think it would be risky to give these effects too much interpretive weight or to further probe the way in which they might contribute to variation in attachment style.



Table 3  
*Global Anxiety (Relationships Scales Questionnaire Anxiety) as a Function of Covariates and Developmental Antecedents*

Predictor	<i>B</i>	<i>SE</i>	$\beta$	<i>p</i>
Covariates				
Gender	-.03	.06	-.02	.59
Ethnicity	.02	.08	.01	.78
Maternal education	-.00	.02	-.01	.78
Family income	-.11	.11	-.05	.29
Global avoidance	<b>.57</b>	<b>.05</b>	<b>.46</b>	<b>&lt;.01</b>
Caregiving environment				
Sensitivity (intercept)	.01	.04	.01	.85
Sensitivity (slope)	-.01	.03	-.02	.67
Maternal depression (intercept)	.02	.03	.03	.521
Maternal depression (slope)	<b>.10</b>	<b>.03</b>	<b>.12</b>	<b>&lt;.01</b>
Father absence	-.04	.07	-.02	.55
Social competence				
Social competence (intercept)	-.02	.05	-.02	.73
Social competence (slope)	<b>-.13</b>	<b>.05</b>	<b>-.12</b>	<b>&lt;.01</b>
Friendship quality				
Friendship quality (intercept)	-.03	.03	-.04	.31
Friendship quality (slope)	.04	.04	.04	.29

*Note.* The intercept for the model was .75. The  $R^2$  of the model was .27,  $F(14, 691) = 18.48$ ,  $p < .05$ . The  $R^2$  of the same model, excluding attachment-related avoidance as a covariate, was .13. Boldface is used to highlight statistically significant predictors. Gender was coded as 0 for female and 1 for male. Ethnicity was coded as 1 for White/non-Hispanic and 0 otherwise.

### Caveats Regarding Developmental Antecedents

Attachment theory is sometimes portrayed as implying that adult attachment styles are largely rooted in early attachment experiences (e.g., Hendrick & Hendrick, 1994). Although the present findings suggest that individual differences in adult attachment may have their origins, in part, in developmental experiences, it is important to note that, in absolute terms, the associations we report were relatively

small. Collectively, the antecedents we examined explained, at most, 29% of the variation in global avoidance, for example. Thus, it is certainly not the case that individual differences in adult attachment are largely a result of early caregiving experiences, at least with respect to the factors investigated in the present report.

The idea that early caregiving experiences should be fully or largely responsible for individual differences in attachment style

Table 4  
*Romantic Avoidance (Experiences in Close Relationships–Revised Avoidance) as a Function of Covariates and Developmental Antecedents*

Predictor	<i>B</i>	<i>SE</i>	$\beta$	<i>p</i>
Covariates				
Gender	-.14	.08	-.06	.08
Ethnicity	<b>-.25</b>	<b>.10</b>	<b>-.09</b>	<b>.01</b>
Maternal education	.03	.02	.07	.10
Family income	.04	.14	.01	.77
Romantic anxiety	<b>.26</b>	<b>.03</b>	<b>.27</b>	<b>&lt;.01</b>
Caregiving environment				
Sensitivity (intercept)	.01	.05	.01	.82
Sensitivity (slope)	<b>-.14</b>	<b>.04</b>	<b>-.12</b>	<b>&lt;.01</b>
Maternal depression (intercept)	-.00	.04	-.00	.99
Maternal depression (slope)	.02	.04	.02	.63
Father absence	-.05	.09	-.02	.57
Social competence				
Social competence (intercept)	-.06	.06	-.04	.35
Social competence (slope)	<b>-.18</b>	<b>.06</b>	<b>-.11</b>	<b>.01</b>
Friendship quality				
Friendship quality (intercept)	<b>-.21</b>	<b>.04</b>	<b>-.18</b>	<b>&lt;.01</b>
Friendship quality (slope)	<b>-.49</b>	<b>.04</b>	<b>-.41</b>	<b>&lt;.01</b>

*Note.* The intercept for the model was 2.05. The  $R^2$  of the model was .33,  $F(14, 677) = 23.26$ ,  $p < .05$ . The  $R^2$  of the same model, excluding attachment-related anxiety as a covariate, was .26. Boldface is used to highlight statistically significant predictors. Gender was coded as 0 for female and 1 for male. Ethnicity was coded as 1 for White/non-Hispanic and 0 otherwise.

Table 5  
*Romantic Anxiety (Experiences in Close Relationships–Revised Anxiety) as a Function of Covariates and Developmental Antecedents*

Predictor	<i>B</i>	<i>SE</i>	$\beta$	<i>p</i>
Covariates				
Gender	.02	.09	.01	.84
Ethnicity	.00	.11	.00	.96
Maternal education	.00	.02	.01	.86
Family income	-.09	.16	-.03	.56
Romantic avoidance	<b>.32</b>	<b>.04</b>	<b>.31</b>	<b>&lt;.01</b>
Caregiving environment				
Sensitivity (intercept)	.08	.06	.07	.15
Sensitivity (slope)	-.01	.05	-.01	.89
Maternal depression (intercept)	-.00	.05	-.00	.94
Maternal depression (slope)	<b>.25</b>	<b>.05</b>	<b>.20</b>	<b>&lt;.01</b>
Father absence	.00	.10	.01	.98
Social competence				
Social competence (intercept)	-.06	.07	-.04	.39
Social competence (slope)	<b>-.30</b>	<b>.07</b>	<b>-.19</b>	<b>&lt;.01</b>
Friendship quality				
Friendship quality (intercept)	.08	.05	.07	.11
Friendship quality (slope)	<b>.22</b>	<b>.05</b>	<b>.18</b>	<b>&lt;.01</b>

*Note.* The intercept for the model was 1.67. The  $R^2$  of the model was .21,  $F(14, 677) = 12.45$ ,  $p < .05$ . The  $R^2$  of the same model, excluding attachment-related avoidance as a covariate, was .13. Boldface is used to highlight statistically significant predictors. Gender was coded as 0 for female and 1 for male. Ethnicity was coded as 1 for White/non-Hispanic and 0 otherwise.

has been criticized by a number of scholars (e.g., Hazan & Shaver, 1994). There are at least three reasons why scholars should not expect large associations between early experiences and adult attachment styles. One reason is that individual differences in adult attachment styles are known to be strongly influenced by people’s ongoing experiences in interpersonal relationships. For example, Pierce and Lydon (2001) demonstrated in a daily-diary study that the majority of the variation in adult attachment patterns existed within persons rather than between persons. Part of the explanation for this, according to Pierce and Lydon, is that individual differences in attachment partly reflect the ongoing experiences that people have in their interpersonal relationships. In another daily-diary study, La Guardia, Ryan, Couchman, and Deci (2000)

showed that individuals tended to increase in security on days when their interpersonal needs were fulfilled and to decrease in security on days in which their needs were not. These kinds of findings are important not only because they help identify the sources of within-person variation in attachment styles but because they highlight the fact that much of the variation in attachment styles is contextual and varies within persons. As such, the likelihood that early experiences play a role in shaping individual differences assessed at any one point in time in adulthood (i.e., a snapshot of interpersonal functioning) has to be considered against the background of knowledge that much of the variance in adult attachment can be understood as a result of more proximate causes.

Table 6  
*Global Avoidance (Relationships Scales Questionnaire Avoidance) as a Function of Covariates and Temperament*

Predictor	<i>B</i>	<i>SE</i>	$\beta$	<i>p</i>
Covariates				
Gender	-.03	.05	-.02	.51
Ethnicity	<b>-.20</b>	<b>.06</b>	<b>-.12</b>	<b>&lt;.01</b>
Maternal education	.01	.01	.05	.26
Family income	-.03	.08	-.00	.74
Global anxiety	<b>.38</b>	<b>.03</b>	<b>.48</b>	<b>&lt;.01</b>
Temperament				
Shyness	-.01	.02	-.01	.83
Attentional focusing	-.00	.03	-.00	.98
Fearfulness	-.03	.02	-.05	.19
Restlessness/activity	.06	.04	.06	.10

*Note.* The intercept for the model was 1.43. The  $R^2$  of the model was .26,  $F(9, 665) = 25.29$ ,  $p < .05$ . The  $R^2$  of the same model, excluding attachment-related anxiety as a covariate, was .04. Boldface is used to highlight statistically significant predictors. Gender was coded as 0 for female and 1 for male. Ethnicity was coded as 1 for White/non-Hispanic and 0 otherwise.

Table 7  
*Global Anxiety (Relationships Scales Questionnaire Anxiety) as a Function of Covariates and Temperament*

Predictor	<i>B</i>	<i>SE</i>	$\beta$	<i>p</i>
Covariates				
Gender	-.01	.06	-.00	.96
Ethnicity	.04	.08	.02	.57
Maternal education	.00	.02	-.01	.98
Family income	-.09	.10	-.04	.38
Global avoidance	<b>.60</b>	<b>.04</b>	<b>.48</b>	<b>&lt;.01</b>
Temperament				
Shyness	-.05	.03	-.06	.08
Attentional focusing	.04	.04	.04	.36
Fearfulness	.04	.03	.05	.12
Restlessness/activity	.08	.04	.07	.06

*Note.* The intercept for the model was .01. The  $R^2$  of the model was .25,  $F(9, 665) = 24.41$ ,  $p < .05$ . The  $R^2$  of the same model, excluding attachment-related avoidance as a covariate, was .03. Boldface is used to highlight statistically significant predictors. Gender was coded as 0 for female and 1 for male. Ethnicity was coded as 1 for White/non-Hispanic and 0 otherwise.

Another reason why we should not expect a large association between early caregiving experiences and subsequent outcomes is that the quality of the caregiving environment is itself subject to change. For example in the NICHD SECCYD, observer ratings of maternal sensitivity in parent-child relationships correlated .27 to .49 with one another across multiple assessment waves, ranging from early infancy to age 15 (Fraley, Roisman, & Haltigan, 2012). Thus, although there is stability across time in the quality of caregiving that children receive, it is possible that the stability of the caregiving environment places an upper limit on the extent to which child outcomes can be influenced by it. In other words, it would be unlikely to expect early maternal sensitivity to predict adult attachment styles to the same degree that it predicts subsequent assessments of maternal sensitivity over time.

A third reason why scholars should expect only small to moderate associations between early experiences and adult attachment styles is that, theoretically, attachment styles are believed to be a function of a number of factors. Research has demonstrated, for example, that adult attachment styles vary as a function of contextual priming (e.g.,

Gillath, Selcuk, & Shaver, 2008), the transition to parenthood (e.g., Simpson, Rholes, Campbell, Tran, & Wilson, 2003), therapeutic intervention (e.g., Kirchmann et al., 2012), and subjectively construed life events (e.g., Davila & Sargent, 2003). Obviously these are not independent factors, but to the extent to which multiple factors contribute to the variation in adult attachment, the explanatory power of any one of them *relative to the rest* is necessarily diminished (see Ahadi & Diener, 1989; Strube, 1991).

In considering the ongoing influence of early experiences, Hazan and Shaver (1987) drew upon Freud's architectural metaphor regarding the city of Rome. They wrote,

The foundations and present shapes of mental models of self and social life still bear similarities and connections to their predecessors—some of the important historical landmarks, bridges, and crooked streets are still there. But few of the ancient structures exist unaltered or in mental isolation. (Hazan & Shaver, 1987, p. 523)

Like Hazan and Shaver, we think it would be a mistake to assume that the organization of an individual's attachment-related

Table 8  
*Romantic Avoidance (Experiences in Close Relationships-Revised Avoidance) as a Function of Covariates and Temperament*

Predictor	<i>B</i>	<i>SE</i>	$\beta$	<i>p</i>
Covariates				
Gender	.09	.09	.04	.33
Ethnicity	<b>-.31</b>	<b>.11</b>	<b>-.11</b>	<b>.01</b>
Maternal education	.04	.02	.08	.07
Family income	-.02	.16	-.01	.90
Romantic anxiety	<b>.31</b>	<b>.04</b>	<b>.32</b>	<b>&lt;.01</b>
Temperament				
Shyness	-.06	.04	-.06	.13
Attentional focusing	-.04	.06	-.03	.52
Fearfulness	.01	.04	.01	.77
Restlessness/activity	.04	.07	.03	.51

*Note.* The intercept for the model was 1.84. The  $R^2$  of the model was .13,  $F(9, 643) = 10.27$ ,  $p < .05$ . The  $R^2$  of the same model, excluding attachment-related anxiety as a covariate, was .03. Boldface is used to highlight statistically significant predictors. Gender was coded as 0 for female and 1 for male. Ethnicity was coded as 1 for White/non-Hispanic and 0 otherwise.

Table 9  
*Romantic Anxiety (Experiences in Close Relationships–Revised Anxiety) as a Function of Covariates and Temperament*

Predictor	<i>B</i>	<i>SE</i>	$\beta$	<i>p</i>
Covariates				
Gender	-.02	.09	-.01	.83
Ethnicity	.09	.12	.03	.43
Maternal education	.01	.02	.03	.57
Family income	-.01	.16	-.01	.95
Romantic avoidance	<b>.33</b>	<b>.04</b>	<b>.32</b>	<b>&lt;.01</b>
Temperament				
Shyness	-.03	.04	-.03	.51
Attentional focusing	.08	.06	.06	.19
Fearfulness	.06	.04	.05	.20
Restlessness/activity	.04	.07	.03	.53

*Note.* The intercept for the model was .74. The  $R^2$  of the model was .11,  $F(9, 652) = 9.22, p < .05$ . The  $R^2$  of the same model, excluding attachment-related avoidance as a covariate, was .01. Boldface is used to highlight statistically significant predictors. Gender was coded as 0 for female and 1 for male. Ethnicity was coded as 1 for White/non-Hispanic and 0 otherwise.

thoughts and behaviors in early adulthood must necessarily resemble that which existed in early childhood. There are undoubtedly some similarities, and in some of our research, we have attempted to draw explicit attention to the role of early experiences per se in shaping social development (e.g., Fraley et al., 2012; Haltigan, Roisman, & Fraley, in press; Roisman & Fraley, 2012). But ultimately, adolescence and the transition to young adulthood present a number of new challenges and opportunities that have the potential not only to confirm existing working models but to recalibrate them as well.

In this spirit we believe it is important to highlight that the most consistent predictors in our multiple regression analyses of adult attachment were *changes* in the various antecedents we examined. For example, decreases in social competence from childhood to adolescence were more robust predictors of attachment insecurity than were early levels of social competence per se. It is also noteworthy that with respect to the relative magnitude of the regression coefficients, decreases in friendship quality over time were more influential in predicting global avoidance than were decreases in family of origin variables (i.e., maternal sensitivity, maternal depression, father absence). These kinds of findings suggest that understanding variation in adult attachment requires attention not only to early experiences but, perhaps more importantly, to ongoing experiences in family and peer relationships.

Although our findings were broadly consistent with the implications of social psychological attachment theory, one of our findings was inconsistent with the theory. Namely, we found that individuals who reported more romantic anxiety at age 18 were more likely to have exhibited *increases* in friendship quality over time. We do not have a way to account for this finding within the framework of attachment theory. If we were to speculate, however, we would suggest that some individuals who experience high-quality friendships in later adolescence might be falling in love with their friends. As such, they might be concerned about losing the person to whom they feel emotionally connected (Eastwick & Finkel, 2008). Another possibility is that individuals who experience anxiety about romantic relationships invest more heavily in friendships as a way of compensating for their lack of certainty about romantic relationships. In considering potential explanations for this unex-

pected finding, we should note that the bivariate relations between romantic anxiety and changes in friendship quality (see Table 1) were not significant, so the regression estimate could reflect a subtle statistical suppression effect and may or may not be stable. We encourage readers to take these interpretations cautiously until they can be replicated and until more nuanced implications of these (or alternative) explanations can be tested.

One of the findings to emerge from these analyses was that the associations among early experiences and attachment style were stronger and more robust when attachment style was assessed with the RSQ than with the ECR-R. There are at least two possible explanations for this finding. First, the RSQ, by design, is a more general assessment of attachment style. The instructions for the instrument emphasize close relationships, and as a result, people’s self-reports may reflect an amalgamation of the thoughts and feelings they have in relation to their primary caregivers, close friends, and romantic partners. In contrast, the ECR-R is designed to assess attachment in the context of romantic relationships. It seems reasonable to hypothesize that to the extent to which early experiences in the family of origin and childhood/adolescent friendships influence later relationship functioning, they will be most likely to do so in a way that might be reflected in these more general assessments of close relationships than in romantic relationships per se. A second and not mutually exclusive possibility is that being focused more on romantic relationships, the ECR-R might be subject to sources of variance (e.g., whether the respondent is or is not in a romantic relationship) that are not reflected as strongly in the RSQ. Indeed, post hoc analyses indicate that participants who were involved in romantic relationships at the time of the assessment had lower ECR-R avoidance scores than those who were not ( $r = -.41$ ) and that this correlation was stronger than the corresponding correlation between involvement in a relationship and RSQ avoidance scores ( $r = -.15; z = -5.31, p < .05$ ). Although statistically controlling relationship status in our analyses did not change any of our findings, the fact that scores on the ECR-R are moderately to strongly correlated with relationship status implies that there may be less variance left over to be accounted for by experiences in early childhood and adolescence.



Table 10

Summary of Previous Research on Adult Attachment Styles and Single-Nucleotide Polymorphisms and Results of Replication Analyses

Gene	Marker	Citation	Adult attachment measure <sup>a</sup>	Summary of original result	Replication test <sup>b</sup>
DRD2 A1 dopamine receptor allele	rs1800497	Gillath et al. (2008)	ECR	Anxiety: TT > (CTICC)	ECR-R anxiety $\beta = -.03, p = .47$ CTICC ( $n = 456$ ): $M = 2.74, SD = 1.24$ TT ( $n = 20$ ): $M = 2.53, SD = 1.19$
Oxytocin OXTR	rs53576	Costa et al. (2009)	J. A. Feeney et al. (1994)	Confidence (security): GG < (GAIAA)  Need for approval (insecurity): GG > (GAIAA)	RSQ anxiety GG vs. (GAIAA) $\beta = .02, p = .67$ GAIAA ( $n = 275$ ): $M = 2.02, SD = .86$ GG ( $n = 200$ ): $M = 2.05, SD = .89$ RSQ avoidance GG vs. (GAIAA) $\beta = -.04, p = .36$ GAIAA ( $n = 275$ ): $M = 2.36, SD = .72$ GG ( $n = 200$ ): $M = 2.30, SD = .66$
Oxytocin OXTR	rs2254298	Chen & Johnson (2012)	ECR	Anxiety: GG < (AGIAA) (in women only)	ECR-R anxiety For women only GG vs. (AGIAA) $\beta = .01, p = .96$ Across genders GG vs. (AGIAA) $\beta = -.02, p = .72$ AGIAA ( $n = 113$ ): $M = 2.73, SD = 1.26$ GG ( $n = 362$ ): $M = 2.73, SD = 1.23$
		Costa et al. (2009)	J. A. Feeney et al. (1994)	Relationships as secondary (avoidance): GG > (GAIAA)	RSQ avoidance GG vs. (GAIAA) $\beta = .03, p = .49$ GAIAA ( $n = 116$ ): $M = 2.30, SD = .65$ GG ( $n = 370$ ): $M = 2.35, SD = .70$
Serotonin receptor gene HTR2A	rs6313	Gillath et al. (2008)	ECR	Avoidance: TT > CC	ECR-R avoidance  TT vs. CC $\beta = -.08, p = .20$ CC ( $n = 160$ ): $M = 3.13, SD = 1.17$ TT ( $n = 88$ ): $M = 2.91, SD = 1.17$
		Salo et al. (2011)	RQ	Anxiety: CC > (TT TC)	RSQ anxiety CC > (TT TC): $\beta = .11, p = .02$ TT TC ( $n = 276$ ): $M = 1.95, SD = .86$ CC ( $n = 165$ ): $M = 2.14, SD = .88$
		Salo et al. (2011)	RQ	HTR2A $\times$ Nurturance interaction. There was an inverse association between maternal nurturance and avoidance among those in the TT genotype group, but not among those in the TC or CC group.	No interaction with TT status and maternal sensitivity in predicting RSQ avoidance. However, there was an interaction with TT status and changes in maternal sensitivity in predicting ECR-R avoidance ( $\beta = -.13, p = .02$ ) such that the association was stronger among those in the TT genotype group (simple slope = $-.52, p < .01$ ) than in the combined TC CC group (simple slope = $-.20, p < .01$ ).

(table continues)

Table 10 (continued)

Gene	Marker	Citation	Adult attachment measure <sup>a</sup>	Summary of original result	Replication test <sup>b</sup>
$\mu$ -opioid OPRM1	rs1799971	Troisi et al. (2012)	RQ	OPRM1 $\times$ Caregiving interaction. Caregiving was negatively related to fearful (high-anxiety, high-avoidance) attachment in the AA genotype group, but not in the (AG GG) genotype group.	No interaction between intercepts or slopes of maternal sensitivity and genotype (AA vs. AG GG) on RSQ avoidance or RSQ anxiety.

<sup>a</sup> The Experiences in Close Relationships (ECR) and the Experiences in Close Relationships–Revised (ECR-R) are derivatives of the same item pool. Thus, we conducted replication tests of published findings that used the ECR using the corresponding ECR-R dimension. Similarly, the Relationships Questionnaire (RQ) and the Relationships Scales Questionnaire (RSQ) were both developed by Bartholomew and are designed to assess global attachment orientation. Thus, we used the RSQ to conduct replication tests of findings based on the RQ. The J. A. Feeney, Noller, and Hanrahan (1994) measure is also a global measure of attachment style. Thus, we used the RSQ to conduct our replication tests. Because the scales are not identical in these two situations, we examined both the anxiety and avoidance dimensions of the RSQ for such tests. <sup>b</sup> Replication tests involved estimating the parameters of the following model: attachment dimension = intercept + ethnicity (White/non-Hispanic = 1, other = 0) + genotype group (0 vs. 1) + residual. Standardized regression coefficients are reported in the right-most column of the table.

### Temperament and Genetic Antecedents of Adult Attachment

One of our objectives in this report was to examine some of the conjectured genetic antecedents of adult attachment style. In recent years, an increasing number of research teams have reported links between a variety of genetic polymorphisms and attachment style. We were able to replicate conceptually the findings reported by Salo et al. (2011). Namely, we found that variation in the HTR2A rs6313 SNP predicted global anxiety such that individuals carrying two C alleles reported more attachment-related anxiety than individuals carrying only one C allele or no C alleles. Moreover, we found an interaction between HTR2A variation and maternal sensitivity such that the negative association between attachment-related avoidance and changes in sensitivity was strongest among those in the TT genotype group. That said, it is important to point out that this is a replication of the Salo et al. finding only in a loose sense. Specifically, we only found the interaction for maternal sensitivity slopes (not intercepts). More importantly, we found that the slopes were negative for both genotype groups, whereas Salo et al. (using maternal report rather than observational data on maternal sensitivity) found that the association between avoidance and caregiving was zero for individuals who were CT or CC. In short, the Gene  $\times$  Environment interaction we observed indicates that TT carriers are particularly sensitive to changes in the caregiving environment; it does not indicate that such an effect exists only among those in the TT genotype group.

Generally speaking, however, we found little evidence that adult attachment styles had temperamental or genetic antecedents. One potential implication of these findings is that adult attachment styles have relatively little to do with the kinds of temperamental dispositions that are observed and studied in childhood. Moreover, the fact that we were only able to identify one genetic main effect on attachment styles that replicates previously published findings

indicates that genetic variation of the kind measured in this report might play a relatively minor role in explaining variation in adult attachment styles. We recognize, of course, that it would be premature to claim that genetic variation explains, say, less than 1% of the variation in adult attachment styles because there could well be polymorphisms not yet identified that have powerful effects. We hope future research and methodological developments will be able to speak to this issue more directly.

In the meantime, how do we reconcile the data on the relative lack of association between temperamental and genetic variation and attachment style with the findings from behavior genetic research that suggest that a sizable portion of the variation in adult attachment styles is due to additive genetic variance (e.g., Donnellan et al., 2008)? One thing to consider is that estimates of the heritability of adult attachment styles have been based exclusively on behavior genetic studies using twin designs (i.e., studies in which the similarity of monozygotic [MZ] twins who share 100% of their genes is compared to that of dizygotic [DZ] twins who share an average of 50% of their genetic variation). The biometric models that are used to estimate heritability in such designs assume that MZ and DZ twins have comparable environments with respect to the attributes in question. When the *equal environments assumption* is violated, environmental effects that covary with genetic relatedness are attributed to genetic effects rather than shared environmental effects.

To the best of our knowledge, the equal environments assumption has not been tested explicitly in behavior genetic studies of adult attachment. Nonetheless, a growing body of evidence suggests that the relational environments of twins are not identical. For example, Fraley and Tancredy (2012) found that MZ twins were more likely to use one another as attachment figures than were DZ twins or nontwin siblings. In addition, the kinds of factors that facilitate bonding (e.g., spending time together, sharing expe-

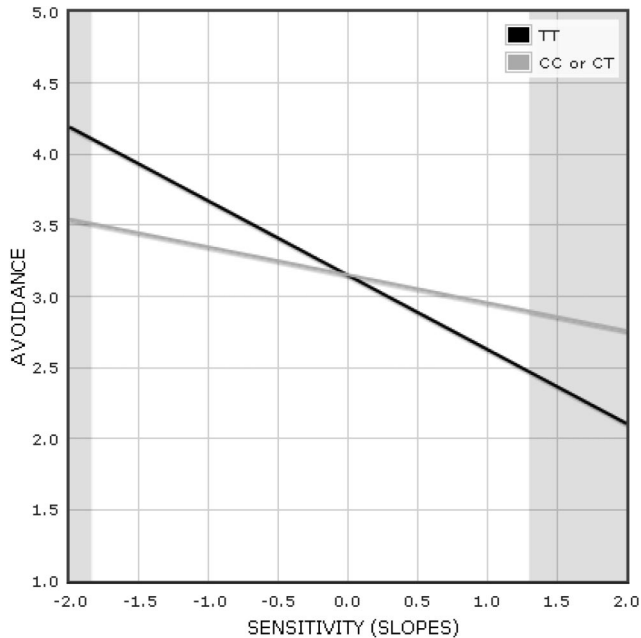


Figure 2. Gene (HTR2A)  $\times$  Environment interaction (maternal sensitivity slopes) in the prediction of romantic avoidance. Shaded gray areas represent regions of significance (i.e., ranges of standardized sensitivity slopes at which the genotype groups were significantly different with respect to romantic avoidance). The regressions of avoidance on changes in sensitivity were significant for both genotype groups.

periences) are more common among twins than nontwins (Tancredy & Fraley, 2006). Thus, it seems possible that one reason why MZ twins are more similar to one another than are DZ twins in their attachment orientations is that the MZ twins are more interdependent (and, thus, more likely to converge in their emotional and interpersonal experiences) than are DZ twins. This state of affairs is likely to inflate estimates of the additive genetic contribution to variation in attachment styles or, more specifically, underestimate the contribution of shared environmental factors.

A second thing to consider is that there is a large gap in the inferences that have been drawn about the role of genes in understanding individual differences in a wide variety of phenotypes based on twin designs compared with studies of SNPs (Turkheimer, 2012; Zuk, Hechter, Sunyaev, & Lander, 2012). Most behavior genetic research based on twin designs suggests that a sizable portion of variation in physical and psychological attributes is due to genetic variation. For example, estimates of the heritability of physical height based on twin studies range from .68 to .93 (Silventoinen et al., 2003). In contrast, research on SNPs rarely has been able to explain much variation at all. For example, investigators studying the genetics of height have generally been unable to identify genes that, in combination, explain more than 10% of the variation in height (Allen et al., 2010). As a result of this gap, if one were to read the molecular genetics literature, one might conclude that it is nearly impossible to explain a sizable portion of variation in height on the basis of genetic variation. In contrast, if one were to read the behavior genetics literature, one might conclude that there is relatively little needed to explain variation in height other than genetic variation.

Needless to say, the “mystery of missing heritability” (Zuk et al., 2012, p. 1193) is becoming more salient in psychological research. It might be the case that researchers simply need more time to identify the right genes, the right epigenetic processes (e.g., Bagot & Meaney, 2010), or the right additive and nonadditive combination of genes (e.g., Yang et al., 2010).

Just to be clear: We are not suggesting that temperamental and genetic qualities do not help explain variation in adult attachment styles. We are claiming, however, that evidence of heritability from twin studies should not lead scholars to disregard the kinds of developmental experiences that have been emphasized by attachment theorists. Elucidating the complex relations among genes, social experiences, and their interactions remains a potentially fertile field for future research.

### Limitations and Future Directions

One of the advantages of using data from the NICHD SECCYD is that doing so enabled us to examine a relatively large sample of individuals who had been assessed on multiple occasions from birth to age 15. Moreover, the SECCYD contains rich data on social development, including observations of parent–child interactions, parent and teacher reports of social competence, and child reports of friendship quality.

Despite these strengths, there are some noteworthy limitations of the present research. First, from the point of view of a prototypical social psychological research study on adult attachment, the sample is relatively young. It will be important to continue to assess attachment in a variety of ways as these individuals enter their 20s and venture away from home. The transition to adulthood has the potential to create changes in people’s working models of attachment. Although some individuals will likely enter into relationships that confirm and reinforce their global expectations concerning attachment relationships (e.g., Brumbaugh & Fraley, 2006), others are likely to experience relationships that demand a unique set of assumptions, expectations, communication styles, and affective experiences. In other words, as people enter into new relationships and increasingly come to rely on peers for attachment-related functions, there are an increasing number of opportunities for attachment to change in ways that can create discontinuities across time (Hazan & Shaver, 1994).

A second limitation of the present research is that we did not assess attachment-related anxiety and avoidance with respect to people’s caregivers. (The RSQ is a global measure of attachment, and the ECR-R is a measure of attachment in romantic relationships.) Previous research has revealed that when the same self-report items are used to assess anxiety and avoidance in romantic versus parental relationships, the association between the two domains is relatively modest (see Baldwin, Keelan, Fehr, Enns, & Koh-Rangarajoo, 1996; Klohnen, Weller, Luo, & Choe, 2005). This suggests that to better understand the way in which developmental experiences might organize attachment-related thoughts, feelings, and goals within an individual, it will be necessary to assess attachment in distinct relational domains. It might be the case, for example, that early caregiving experiences more strongly predict adult representations of attachment in parental domains than in global or romantic domains. It might also be the case that early caregiving experiences with parents are better predictors of one’s own parenting behavior as an adult than are one’s experi-

ences with peers. We hope future research with this sample will be able to speak to some of these possibilities.

A third limitation of the present research is that we do not have repeated measures of attachment style. Thus, although these data are developmentally rich with respect to antecedents (i.e., particularly with regard to the repeated observations of caregiving across time), they are not developmentally rich with respect to adult attachment (i.e., there is only a single snapshot of adult attachment at age 18 assessed in the context of a one-time follow-up study; see Booth-LaForce & Roisman, 2012). As such, the assessments of adult attachment might contain contextual variance that would potentially average out across multiple assessments. If adult attachment were to be assessed across multiple occasions, the component of variation that is stable across time might be more strongly related to caregiving experiences than any single assessment (Fraley, 2002). This kind of prediction can potentially be examined in further developmental studies with this follow-up sample.

A fourth limitation of the present research is that we do not have empirical data on the process by which attachment-related features and functions are transferred from a primary caregiver to peers (e.g., friends or romantic partners). According to Zeifman and Hazan (2008), many adolescents gradually form attachment relationships with peers, and the process by which they come to rely on peers as primary sources for contact, comfort, and support may be aided by having a secure relationship with their primary caregivers. We think it would be valuable to explore these kinds of issues in future prospective research.

Although the focus of our research was on explaining variation in self-reported attachment styles at age 18 years, this is but one of many variables that are of interest to attachment researchers. Attachment theory emphasizes the role of early and ongoing experiences in organizing interpersonal behavior across multiple domains. Indeed, a growing body of prospective research is helping to document the way in which interpersonal behavior might be rooted in people's early experiences. For example, in a sample of 78 young adults studied since birth, Simpson, Collins, Tran, and Haydon (2007) found that early attachment experiences predicted peer competence, friendship security, and both self-reported and observer-rated negative emotion in the context of romantic relationships in early adulthood. In addition, in the same sample, Salvatore, Kuo, Steele, Simpson, and Collins (2011) found that individuals who were rated as securely attached as infants were more likely to recover from relationship conflict better than those who were rated as insecure as infants. In short, early relationship experiences appear to organize a broad array of skills, competencies, and patterns of self-regulation, each of which contribute in beneficial ways to interpersonal functioning. Self-reported attachment styles are one way in which these competencies might manifest, but they are merely one of multiple outcomes that might be of interest to social, developmental, and personality psychologists. We hope that future research will continue to explore the diverse ways in which in which relational experiences potentially organize and shape personality development and interpersonal behavior.

In closing, one of the long-standing assumptions of social psychological research on adult attachment is that individual differences in attachment style have their origins in interpersonal experiences in the family and in peer relationships—experiences that

take place across childhood and adolescence. However, this assumption has not been fully examined via prospective research designs. The results from this large longitudinal sample suggest that variation in adult attachment style can be traced to interpersonal experiences that take place over the course of development. We hope this work will help inspire future research that is capable of investigating in a more nuanced and comprehensive way the developmental processes that give rise to individual differences in adult attachment processes and dynamics.

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Received July 6, 2012

Revision received October 23, 2012

Accepted October 23, 2012 ■