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Newborn Irritability Moderates the Association between Infant Attachment Security and Toddler Exploration and Sociability

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Abstract

This longitudinal investigation of 84 infants examined whether the effect of 12-month attachment on 18- and 24-month exploration and sociability with unfamiliar adults varied as a function of newborn irritability. As expected, results revealed an interaction between attachment (secure vs. insecure) and irritability (highly irritable vs. moderately irritable) in predicting both exploration and sociability with unfamiliar adults. For exploration, results supported a dual-risk model; that is, toddlers who had been both highly irritable and insecurely attached were less exploratory than other toddlers. For sociability, results supported the differential-susceptibility hypothesis; that is, highly irritable infants, compared to moderately irritable infants, were both *less* sociable as toddlers when they had been insecurely attached and *more* sociable when they had been securely attached.

Keywords

attachment; irritability; exploration; sociability; differential-susceptibility

The ability to negotiate the physical and social world is a core developmental competency (e.g., Erikson, 1950/1964; Piaget, 1952/1963; Shonkoff & Phillips, 2000), and as such, children's exploration and sociability have been a focus of considerable research. Although understanding sociability with both peers and unfamiliar adults is important, examination of sociability during the first two years of life has understandably focused on interactions with unfamiliar adults because sociability with peers is typically of limited complexity during that time period (Parten, 1933). These important topics have been examined within a variety of research traditions. For instance, attachment theory (Bowlby, 1969/1982) and research point to attachment quality as a predictor of these outcomes; considerable empirical evidence indicates that security promotes more competent exploration and greater sociability with unfamiliar adults, whereas insecurity is a risk factor for poorer exploratory and sociability outcomes (e.g., Belsky, Garduque, & Hrcir, 1984; Londerville & Main, 1981; Main, 1983; Main & Weston, 1981; Matas, Arend, & Sroufe, 1978; Thompson & Lamb, 1983; van den Boom, 1994). Likewise, temperament theory and research highlight early negative reactivity as a risk factor for poorer exploration and sociability with unfamiliar adults (e.g., Bronson, 1972; Buss & Plomin, 1984; Fish, 1998; Goldsmith & Campos, 1982;

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Gaertner, Spinrad, & Eisenberg, 2008; Gandour, 1989; Kagan, Snidman, & Arcus, 1998; Rothbart & Derryberry, 1981).

Given this converging evidence that both attachment insecurity and negatively reactive temperament are risk factors for poor exploration and sociability, it seems reasonable to assume that attachment and temperament may interact to influence these outcomes. For instance, it may be that negatively reactive infants are disproportionately and adversely affected by attachment insecurity. Highly reactive insecure infants, who are both more easily irritated by environmental perturbations (Kagan & Snidman, 2004) and lack the confidence that their caregivers will be effectively soothing when needed (Bowlby, 1969/1982), may reduce exploration and sociability to prevent becoming overwhelmed or frustrated. Thus, the combination of negative reactivity and insecure attachment may put children at dual-risk for the poorest exploration and sociability outcomes compared to other less negatively reactive infants and those who are securely attached (see Belsky, Bakermans-Kranenburg, & van IJzendoorn, 2007, for delineation of dual-risk conditions; and see Belsky, Hsieh, & Crnic, 1998, and Morrell & Murray, 2003, for empirical support of the dual-risk model).

Another way in which attachment and temperament could interact to predict exploration and sociability emerges from the recently developed differential-susceptibility hypothesis (Belsky, 1997, 2005) and a growing body of related research (for a review, see Belsky & Pluess, 2009). Specifically, negatively reactive infants may not simply be at-risk for poor developmental outcomes. Rather, “some children, for temperamental or genetic reasons, are actually more susceptible to *both* (a) the adverse effects of unsupportive parenting *and* (b) the beneficial effects of supportive rearing” (Belsky et al., 2007, p. 300; see also Boyce & Ellis, 2005, and Ellis & Boyce, 2008, for a related argument). For example, one study examining an outcome that may be related to sociability (i.e., better social adjustment in first grade), found evidence of differential susceptibility: Infants rated as temperamentally difficult at 6 months by their mothers, compared to less difficult infants, had worse social adjustment in first grade when they experienced unsupportive parenting and better social adjustment when they experienced supportive parenting (Stright, Gallagher, & Kelley, 2008). Given that infant-mother attachment quality is a reasonable marker of the supportiveness of the caregiving environment (Bakermans-Kranenburg, van IJzendoorn, & Juffer, 2003), it is possible that negatively reactive infants may not only be at-risk for the poorest exploration and sociability outcomes when they are insecurely attached to mother, but they may also benefit most when they are securely attached to her.

High newborn irritability is a temperamental characteristic that is a potential marker of differential susceptibility (Belsky, 1997, 2005). Highly irritable infants are more negatively reactive and easily irritated by environmental perturbations (Kagan & Snidman, 2004) and they direct attachment behaviors toward their caregivers more frequently than less irritable infants (van den Boom, 1991; for a review see Vaughn & Bost, 1999). Because of the increased frequency with which they direct attachment behaviors toward their caregivers, highly irritable infants may build stronger associations between their display of attachment behaviors and the likely outcome (e.g., being comforted or rejected) because the two are paired more frequently. It stands to reason, therefore, that highly irritable infants may build particularly strong representations of their experiences with their caregivers as either satisfying or unsatisfying which they then carry with them into new interactions with the physical and social environments (see Bowlby, 1969/1982, for a discussion of the application of experience-based attachment representations to new situations).

To our knowledge, only one study has investigated how attachment and newborn temperament interact to predict an outcome similar to exploration and sociability. Calkins and Fox (1992) found a main effect of 14-month attachment quality as a predictor of 24-

month behavioral inhibition (a composite of exploratory and sociability elements), yet this link did not differ as a function of neonatal negative temperament (i.e., whether the newborn cried in response pacifier withdrawal). These findings, however, were based on very small cell sizes (i.e., fewer than 5 infants in multiple cells).

In the present study, we examined the possibility that highly irritable newborns may be differentially susceptible to *both* the beneficial effects of attachment security *and* the adverse effects of attachment insecurity on later exploration and sociability with unfamiliar adults. We selected infants at two levels of irritability: (a) those who met a previously used criterion for high irritability (Cassidy, Woodhouse, Sherman, Stupica, & Lejuez, 2010; van den Boom, 1994), that is, infants whose irritability scores were six or greater on two Neonatal Behavioral Assessment Scale (NBAS; Brazelton & Nugent, 1995) exams; and (b) those whose irritability scores fell within the top 20% of the screened infants, but did not meet criteria for *high* irritability. We refer to these infants as moderately irritable. By selecting both highly irritable and moderately irritable infants, we were able to test the following two hypotheses.

First, we hypothesized that the link between attachment insecurity and decreased exploration and sociability with unfamiliar adults would be stronger for highly irritable infants than for moderately irritable infants. Second, following the tenets of the differential-susceptibility hypothesis, we predicted that highly irritable infants, compared to moderately irritable infants, would have (a) more negative outcomes under unsupportive rearing environments (i.e., poorer exploration and less sociability when insecurely attached to mother) *and* (b) more positive outcomes under supportive rearing environments (i.e., greater exploration and greater sociability when securely attached to mother).

Method

Participants

Participants were 84 irritable infants (38 girls, 46 boys) and their economically stressed mothers (70.2% had annual household incomes between \$14,000 and \$45,000) from the non-intervention control group of a two-year randomized control trial (RCT) of an attachment-based intervention. Of the 1103 infants screened twice for newborn irritability, we selected the top 20% most irritable infants resulting in 220 infant-mother dyads enrolled in the RCT. One hundred seventy-four dyads were randomly assigned to either the intervention ($n = 86$) or non-intervention control ($n = 88$) condition. Of the 88 dyads assigned to the control condition, attachment classifications were available for 84 infants; these 84 non-intervention control group infants comprise the sample for the present study. Infants' race/ethnicity was 47.6% African American/Black, 17.9% multi-racial, 17.9% White, 14.3% Hispanic, 1.2% Asian, and 1.2% Native American. Infants' mean birth-weight was 3362.14 grams ($SD = 418.78$). Mothers' average age at enrollment was 24.33 years ($SD = 5.19$).

Procedure

Data were collected in four phases. First, we administered two separate NBAS examinations (Brazelton & Nugent, 1995) at home during the infants' first month. Second, we assessed 12-month infant attachment to mother with the laboratory Strange Situation procedure (Ainsworth, Blehar, Waters, & Wall, 1978). Third, we assessed 18-month infant exploration and sociability with unfamiliar adults during a 40-minute laboratory visit in which dyads participated in a semi-structured play session and a maternal divided attention task. Finally, we assessed 24-month exploration and sociability with unfamiliar adults during a 45-minute laboratory visit which proceeded in the following order: mother-toddler free-play; delay of

gratification task; bubble-play session; 3-minute clown approach; mother-toddler problem-solving task; tunnel task; 4-minute scripted inter-experimenter argument and resolution; and maternal divided-attention task. For all laboratory visits, mothers were present during all tasks. During the 18-month visit, toddlers were with an unfamiliar adult before and after each task (approximate total 15 minutes). During the 24-month visit, toddlers were with unfamiliar adults before and after each task as well as during: the problem-solving task during which an experimenter timed the task and provided assistance if requested; the clown approach when the clown invited toddlers to play; the tunnel task during which an experimenter encouraged toddlers to retrieve a toy from the tunnel; and the inter-experimenter argument during which the two experimenters did not initiate interacting with toddlers (approximate total 30 minutes). Experimenters interacted with the toddlers in a friendly manner while preparing materials for laboratory tasks. Exploration and sociability ratings were based on experimenters' observations of infants' behavior throughout the entire laboratory visit at both time points.

Measures

Infant irritability—Infant irritability was assessed with two NBAS exams (Brazelton & Nugent, 1995) in the home during the first month postpartum. Following Kaye (1978), we created an irritability composite score for each exam by averaging infants' scores on the *peak of excitement*, *rapidity of buildup*, and *irritability* items (each on 9-point scales) from each exam. Composite scores from the first NBAS exam ranged from 4.00 – 8.67 ($M = 6.49$, $SD = .86$), and composite scores from the second NBAS exam ranged from 1.50 – 9.00 ($M = 5.46$, $SD = 1.87$). In the present study, infants whose composite scores were six or greater on both exams were considered highly irritable (Cassidy et al., 2010; van den Boom, 1994), and remaining infants were considered moderately irritable. We use these dichotomous groups for analyses. Inter-coder reliability for the irritability composite score was high ($ICC = .96$ for 9% of cases).

Infant attachment—The Strange Situation (Ainsworth et al., 1978), a 20-minute standardized videotaped assessment, yields infant attachment classifications based principally on infants' behavior during two infant-mother reunions. Because our hypotheses concerned differences between securely and insecurely attached infants, we combined the three insecure groups (i.e., avoidant, resistant, disorganized/disoriented) for analyses. Coder agreement for secure/insecure group placement was 86% ($\kappa = .72$, $p < .001$; 34% of cases).

Exploration—For the 18- and 24-month laboratory visits, exploration was assessed using two items from the Infant Behavior Record (IBR; Bayley, 1969). After each laboratory visit, two experimenters blind to additional information rated children's *object orientation* and *attention span* on 9-point scales. Following previous research, these two items were summed separately for the 18- and 24-month time points creating two exploration scores, one for each time point, with higher scores indicating greater exploration (e.g., Braungart, Plomin, DeFries, & Fulker, 1992; Stifter & Corey, 2001; Wilson & Matheny, 1983). Experimenter ratings were reliable for the 18-month ($ICC = .69$, 88% of cases) and 24-month ($ICC = .62$, 98% of cases) time points.

Sociability with unfamiliar adults—For the 18- and 24-month laboratory visits sociability with unfamiliar adults was assessed using three items from the IBR (Bayley, 1969). After each laboratory visit, two experimenters blind to additional information rated the child's *responsiveness to the experimenter*, *fearfulness*, and *general emotional tone* on 5-point scales. Following previous research, these three items were summed (fearfulness was reverse scored) separately for the 18- and 24-month time points to create two sociability scores, one for each time point, with higher scores indicating greater sociability (e.g.,

Braungart et al., 1992; Stifter & Corey, 2001; Wilson & Matheny, 1983). Experimenters ratings were reliable for the 18-month ($ICC = .88$, 85% of cases) and 24-month ($ICC = .74$, 98% of cases) time points.

Results

Preliminary Analyses

Missing data—Of the 84 infants who completed the Strange Situation, complete data (i.e., exploration and sociability scores at both 18- and 24-months) were available for only 58 infants. We used maximum likelihood estimation and all available data to impute missing outcome values—a technique recommended for handling missing data in longitudinal studies (Jelicic, Phelps, & Lerner, 2009). Given that data were “missing completely at random” (Little’s MCAR test, $\chi^2 [198] = 209.48$, $p = .27$), this approach allowed us to test our hypotheses with improved power over listwise deletion and less biased parameter estimates than other techniques including listwise deletion, mean substitution, and multiple regression estimation (Graham, 2009).

Descriptive statistics—We identified 32 infants (38%) as highly irritable and 52 infants (62%) as moderately irritable. Mean composite irritability scores for the first and second NBAS assessments, respectively, were 6.81 ($SD = 0.71$) and 6.99 ($SD = 0.77$) for highly irritable infants and 6.29 ($SD = 0.88$) and 4.52 ($SD = 1.72$) for moderately irritable infants. Forty-two infants (50%) were classified secure, 14 avoidant (16.7%), 13 ambivalent (15.5%), and 15 disorganized (17.9%), resulting in 42 secure (17 highly irritable, 25 moderately irritable) and 42 insecure infants (15 highly irritable, 27 moderately irritable) for analyses. Infant irritability was not related to attachment $\chi^2(1) = 0.20$, $p = .65$. Exploration scores at 18- ($M = 11.23$, $SD = 2.32$) and 24-months ($M = 12.11$, $SD = 1.92$) were correlated ($r = .23$, $p = .03$), as were sociability scores at 18- ($M = 10.63$, $SD = 2.07$) and 24-months ($M = 10.73$, $SD = 1.62$; $r = .54$, $p < .001$). Exploration and sociability scores were correlated at 18 months ($r = .31$, $p = .004$), but not at 24 months ($r = .16$, $p = .14$).

Principal Analyses

We conducted two analyses using generalized estimating equations (GEE) to determine whether the associations between (a) infant attachment and exploration, and (b) infant attachment and sociability with unfamiliar adults were moderated by level of infant irritability. For each GEE, the 18-month and 24-month assessments were entered as a repeated-measures outcome allowing us to examine changes over time. In both GEEs, we examined the main effects of time (18 vs. 24 months), irritability (highly vs. moderately irritable), and attachment (secure vs. insecure), as well as all possible two-way interactions and the Time \times Attachment \times Irritability interaction using two-tailed tests. We specified an unstructured correlation matrix and conducted our significance tests using the Type I sum of squares approach because of the hierarchical nature of our analyses. We probed significant interactions using the Least Significant Difference method for pairwise comparisons of estimated marginal means. Because we hypothesized that highly irritable infants, compared to moderately irritable infants, would be more susceptible to the influence of attachment, we tested the differences between the estimated marginal means using directional, one-tailed tests.

Exploration—Exploration increased from 18 to 24 months, highly irritable infants were less exploratory than moderately irritable infants, and secure infants were more exploratory than insecure infants (see Table 1). No interactions including the effect of time were significant. As expected, an Attachment \times Irritability interaction emerged, indicating that exploration differed as a function of attachment only for highly irritable infants (mean

difference = 1.76, $p < .001$, one-tailed, $d = 1.26$); exploration for moderately irritable infants did not differ as a function of attachment (mean difference = .03, $p = .48$, one-tailed, $d = .02$; see Figure 1). Further probing revealed that, as expected, highly irritable infants, compared to moderately irritable infants, were less exploratory when insecurely attached (mean difference = -1.64, $p = .002$, one-tailed, $d = .97$). Highly irritable infants' exploration, however, did not differ from that of moderately irritable infants when securely attached (mean difference = .15, $p = .35$, one-tailed, $d = .12$).

Sociability with unfamiliar adults—Sociability did not vary as a function of time, irritability, or attachment (see Table 2). As expected, an Attachment \times Irritability interaction emerged, indicating that sociability differed as a function of attachment only for highly irritable infants (mean difference = 2.11, $p < .001$, one-tailed, $d = 1.33$; see Figure 2); moderately irritable infants' sociability did not differ as a function of attachment (mean difference = -.40, $p = .14$, one-tailed, $d = .30$). Further probing revealed that highly irritable infants, compared to moderately irritable infants, were less sociable when insecurely attached (mean difference = -1.74, $p = .001$, one-tailed, $d = 1.13$); additionally, highly irritable infants, compared to moderately irritable infants, were more sociable when securely attached (mean difference = .77, $p = .03$, one-tailed, $d = .59$).

Discussion

Most research examining the effects of infant attachment on later exploration and sociability with unfamiliar adults has ignored the potential role of infant characteristics. Our study explored the interaction between infant and environmental characteristics by examining whether newborn irritability moderated the effect of infant-mother attachment quality on later exploration and sociability with unfamiliar adults. As predicted, we found that the effect of infant attachment on both outcomes was greater for highly irritable infants compared to moderately irritable infants.

Our examination of the attachment-by-irritability interaction as a predictor of exploration revealed that the combination of high newborn irritability and insecure attachment proved detrimental to toddlers' exploration; we found no evidence that the combination of high irritability and secure attachment was associated with enhanced exploration. This set of findings is consistent with a dual-risk model rather than a model of differential-susceptibility (Belsky & Pluess, 2009). Thus, our findings could be interpreted as an indication that the lack of confidence in the availability and responsiveness of the caregiver that characterizes attachment insecurity may undermine the exploratory efforts of infants who are more reactive and easily irritated by environmental perturbations. Although engaging with the physical environment can be overwhelming or frustrating for any infant, this task can be particularly so for infants who are highly reactive and easily irritated (e.g., Bronson, 1972; Fish, 1998; Gaertner et al., 2008; Gandour, 1989; Kagan et al., 1998). This propensity for becoming easily overwhelmed or frustrated by exploration in combination with a lack of confidence in the caregiver's availability, responsiveness, and ability to be effectively soothing may prevent highly irritable, insecure infants from fully engaging in exploration. Extending previous research that established a main effect of attachment quality predicting exploration, our findings indicate that attachment predicts exploration only for some children. In the present study, attachment quality predicted later exploration only for highly irritable infants; no association was found for moderately irritable infants.

The lack of support for the differential-susceptibility hypothesis in relation to exploration may have resulted from our focus on the child's relatively basic tendency to become engrossed in exploration (a composite of attention span and object orientation) rather than on more cognitively complex and sophisticated levels of exploration. As such, our findings

may indicate a ceiling effect with most children performing well on this dimension. Thus, it remains possible that highly irritable infants benefit more from attachment security than less irritable infants on their ability to engage in more complex and sophisticated exploration. It is also possible that differential susceptibility on this dimension does not emerge until later in development. Future studies can provide further data relevant to the differential-susceptibility hypothesis by focusing on more complex aspects of exploration (e.g., symbolic play) and later points in development.

Our examination of the attachment-by-irritability interaction as a predictor of sociability revealed that highly irritable infants, compared to moderately irritable infants, were less sociable with unfamiliar adults when insecurely attached *and* more sociable when securely attached. These findings are consistent with the differential-susceptibility hypothesis (Belsky & Pluess, 2009) and the growing body of research suggesting that some children are more influenced than others not only by unsupportive rearing environments, but also by supportive ones (see also Ellis & Boyce, 2008). Our findings that highly irritable infants are both the least and the most sociable may stem from the fact that highly irritable infants direct attachment behaviors toward their caregivers more frequently than moderately irritable infants (van den Boom, 1991); as such, irritable infants may build stronger associations between their attachment behaviors and their caregivers' typical response because the two are paired more frequently. These experience-based representations of their interactions with their caregivers as either satisfying or unsatisfying are then carried with them into their interactions with unfamiliar others.

Our findings that infant irritability moderated the effect of infant attachment on both later exploration and sociability with unfamiliar adults are consistent with other Temperament \times Environment research (see Belsky, 2005; Belsky & Pluess, 2009). Our claim that these findings provide information about Temperament \times Environment interactions is based on the assumption that infant attachment is a reasonably accurate reflection of the supportiveness of the caregiving environment. There is ample evidence to justify this view: attachment is neither heritable (Bokhorst, Bakermans-Kranenburg, Fearon, van IJzendoorn, Fonagy, & Schuengel, 2003) nor a trait of the child (e.g., infants can be securely attached to one caregiver and insecurely attached to another; Belsky et al., 1984; Lamb, 1977; Main & Weston, 1981); caregiving quality is causally-related to infant attachment (Bakermans-Kranenburg et al., 2003); and attachment has demonstrated both stability and change that lawfully parallels stability and change in the caregiving environment (Weinfield, Sroufe, & Egeland, 2000). Accordingly, future research should examine how infant temperament interacts with other aspects of the environment (e.g., stressful life events, parental psychopathology, marital conflict) to influence other outcomes (e.g., peer relationships, child psychopathology, physical health).

Our findings that newborn irritability and attachment interacted to predict both exploration and sociability do not converge with previous findings that newborn irritability and attachment did not interact to predict behavioral inhibition (Calkins & Fox, 1992). At least three factors may account for this discrepancy. First, it is possible that Calkins and Fox's (1992) criterion for identifying highly irritable newborns (i.e., cried or did not cry during pacifier withdrawal at 2 days old) did not capture those infants who are most susceptible. Our criterion of newborn irritability, however, identified infants who displayed stable high irritability (i.e., highly irritable at two time-points rather than a single assessment). This distinction of capturing stable high irritability may be meaningful in identifying infants who are more susceptible to caregiving influences. Second, Calkins and Fox's test of the interaction was based on extremely small sample sizes (e.g., only 3 insecure infants did not cry during pacifier withdrawal). Third, behavioral inhibition combines elements of both

exploration and sociability, and these two aspects of behavior may best be considered separately.

It is important to note that our findings speak only to the differences between highly irritable and moderately irritable infants. We are unable to draw conclusions about the influence of attachment for infants who demonstrate low levels of irritability, which limits the generalizability of our findings. Future research should examine the links between attachment and later exploration and sociability using a sample that represents the full range of infant irritability. Nonetheless, the present study extends our knowledge about the influence of attachment and temperament on later exploration and sociability by supporting the notion that infants may differ in their susceptibility to attachment quality as a function of their level of newborn irritability. Specifically, the effects of security on later exploration and sociability are not uniform; highly irritable infants may be disproportionately hindered when they are insecurely attached. In addition, our findings indicate that irritability is not solely a risk factor; highly irritable infants may disproportionately benefit when they are securely attached. More broadly, because these findings add to the growing body of research suggesting that the interaction of environmental influences and infant temperament can contribute to child outcomes, they underscore the importance of not limiting research solely to examination of main effects.

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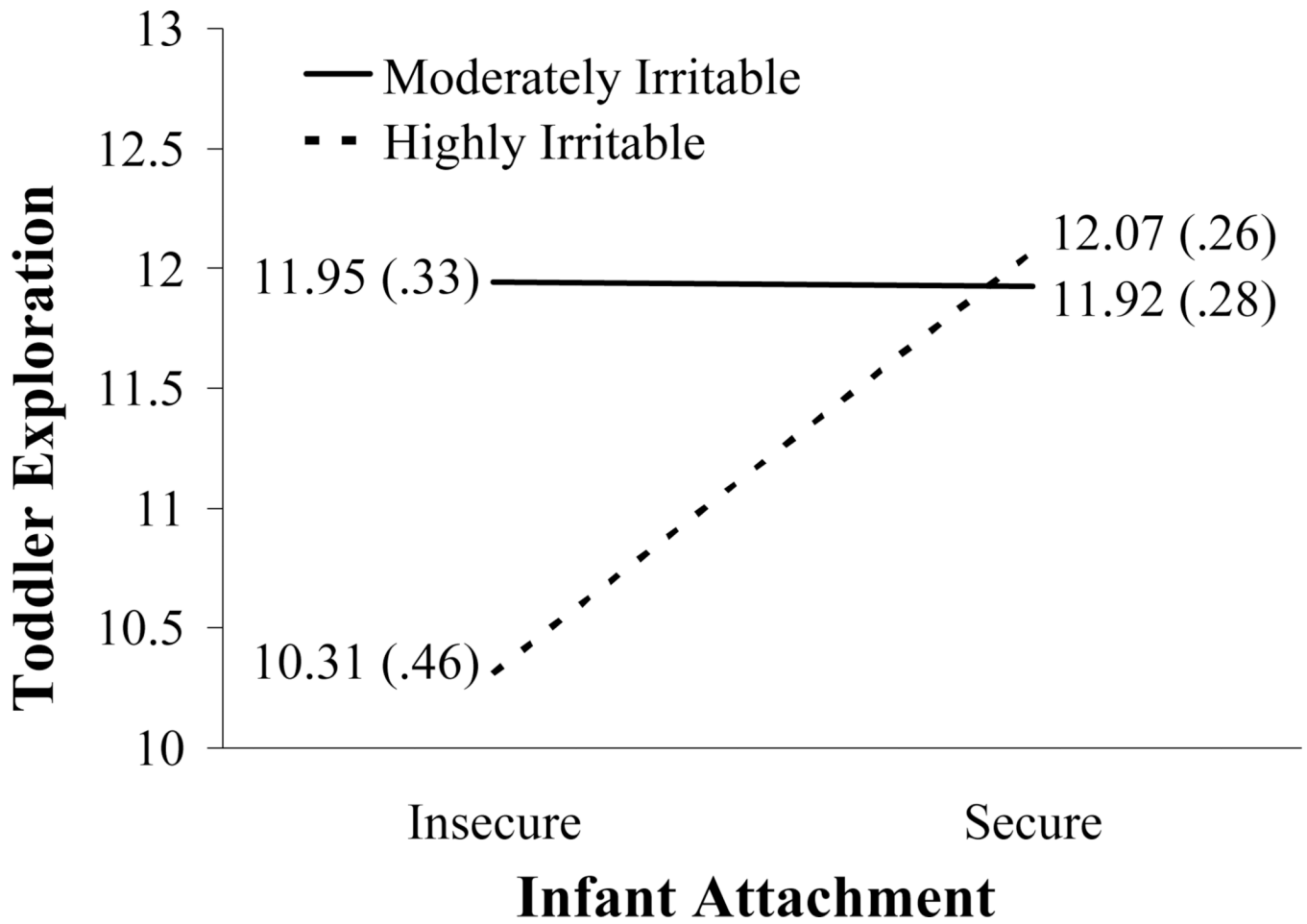


Figure 1. Exploration as a function of infant-mother attachment and infant irritability. Estimated marginal means are presented for each group with standard errors in parentheses. Possible scores range from 2 to 18.

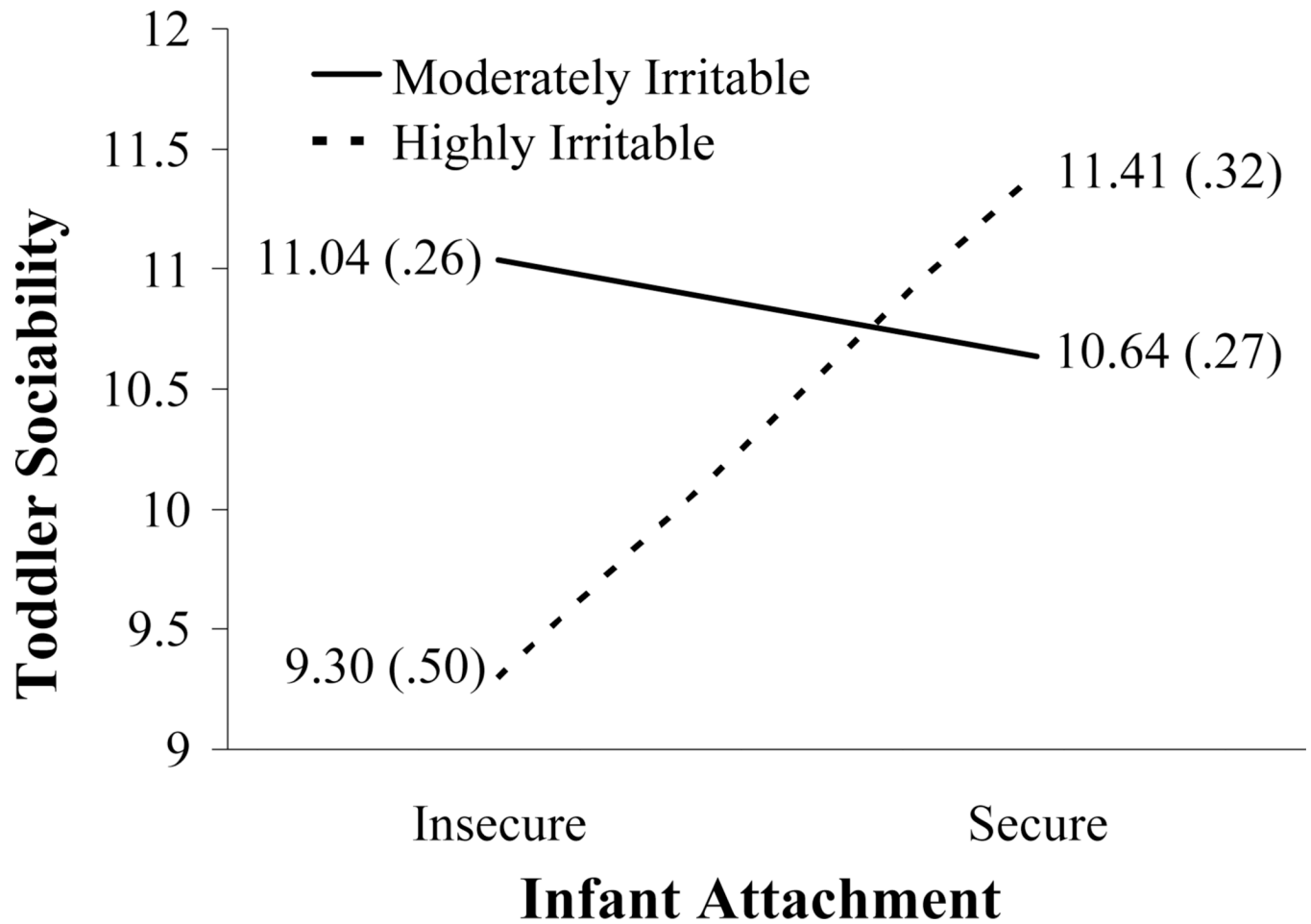


Figure 2. Sociability with unfamiliar adults as a function of infant-mother attachment and infant irritability. Estimated marginal means are presented for each group with standard errors in parentheses. Possible scores range from 3 to 15.

Table 1

GEE Analysis Predicting Exploration

	Wald Chi-Square	<i>p</i> -value
Intercept	4869.08	.001
Time	9.42	.002
Irritability	4.24	.040
Attachment	3.78	.052
Irritability × Time	0.59	.444
Attachment × Time	0.14	.706
Attachment × Irritability	6.81	.009
Attachment × Irritability × Time	0.01	.907

Note. Wald chi-square statistics were tested with 1 degree of freedom using the Type I sum of squares approach, two-tailed.

Table 2

GEE Analysis Predicting Sociability

	Wald Chi-Square	<i>p</i> -value
Intercept	4545.30	.001
Time	0.25	.618
Irritability	1.55	.213
Attachment	2.97	.085
Irritability × Time	1.06	.304
Attachment × Time	0.11	.744
Attachment × Irritability	12.95	.001
Attachment × Irritability × Time	1.64	.201

Note. Wald chi-square statistics were tested with 1 degree of freedom using the Type I sum of squares approach, two-tailed.