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Abstract

Attachment security is theorized to shape stress reactivity, but extant work has failed to find consistent links between attachment security to mothers and infant cortisol reactivity. We examined family configurations of infant-mother and infant-father attachment security in relation to infant cortisol reactivity. One-year old infants (N = 180) participated in the Strange Situation with mothers and fathers in two counterbalanced lab visits, one month apart (12 and 13 months). Infants with secure attachments only to their fathers and not their mothers had higher cortisol levels than infants with a secure attachment to mother and also exhibited a blunted cortisol

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response (high at baseline and then a decrease after stress). Results suggest that a secure attachment to father may not be enough to reduce infant stress reactivity when the infant-mother attachment is insecure, and future research is needed to uncover the family dynamics that underlie different family configurations of attachment security.

Keywords: Cortisol, strange situation, infants, fathers, mothers

Much of the literature on early parent-infant attachment has focused predominantly on mothers as influential attachment figures, and far less on other individuals, including fathers (Dagan & Sagi-Schwartz, 2018). Because fathers have become more involved in parenting in recent decades (McKelley & Rochlen, 2016), increasing numbers of studies have focused on fathers' interactions with infants, the effects of father involvement on infant development, and infant-father attachment relationships, in particular (Braungart-Rieker, Courtney, & Garwood, 1999; Bretherton, 2010; Lickenbrock & Braungart-Rieker, 2015; Volling & Belsky, 1992). Indeed, infants form attachment relationships to both mothers and fathers simultaneously (Howes & Spieker, 2008), particularly in two-parent families. In some cases, secure infant-father attachment relationships predict similar socio-emotional outcomes for children as secure infant-mother attachments (Bretherton, 2010; Grossmann, Grossmann, & Kindler, 2005), but in other instances, they do not (Sagi- Schwartz & Aviezer, 2005; Steele & Steele, 2005), making it less clear what role infant-father attachment security plays in children's development (Grossmann, Grossmann, Kindler, & Zimmermann, 2008). These inconsistent findings may have more to do with how investigators choose to analyze data on infant-mother and infant-father attachment relationships (independently or simultaneously) than on whether there are similar or different effects for fathers and mothers on infant development. The purpose of the current study was to take a family-level perspective and consider the different configurations of infants' attachment security with mothers and fathers together (e.g., secure to mother and father; secure to mother but not father) in understanding infant stress reactivity.

A family-level perspective on attachment

Important questions remain about whether attachment relationships to mothers and fathers jointly predict child development, and how to

theorize about joint effects. Recently, Dagan and Sagi-Schwartz (2018) proposed a more family-friendly perspective by focusing on the network of infant attachment relationships with both mothers and fathers that they claim provides a more ecologically-valid approach to understanding infant development than investigating the infant's attachments with either parent alone. Further, understanding infant-parent attachments as a network of family relationships allows for more refined questions about the influence of multiple attachment relationships on development, such as (1) Does the number of secure attachments matter?; (2) Does the attachment security to one parent (e.g., mother) contribute more to developmental outcomes than attachment security to the other parent?; and (3) Can one secure attachment compensate for an insecure attachment? By taking a family perspective and examining the network of attachment relationships infants formed with their mother and father in the current study, we tested many of these hypothesized effects of attachment security for infant stress reactivity.

Here, we moved beyond the monotropic model proposed by Bowlby (1988) emphasizing the importance of a single attachment to a primary caregiver, and applied the integrative model proposed by Dagan and Sagi-Schwartz (2018) that assumes that the family network of infant attachment relationships to both mothers and fathers predicts child developmental outcomes better than a single infant-parent attachment relationship. To establish family-level patterns of attachment relationships, Dagan & Sagi-Schwartz proposed that attachments can be sorted into four configurations (i.e., secure to both parents, insecure to both, secure only to father, and secure only to mother), which then allows researchers to test four specific hypotheses about the effects of multiple attachment relationships on children's development. The first two hypotheses (*additive-hierarchical, additive-horizontal*) propose that having a greater number of attachments yields more positive outcomes, such that having two secure attachments is better than having one, which in turn, is better than having none. What distinguishes the *additive-hierarchical* hypothesis from the *additive-horizontal* hypothesis are the assumptions made about the importance of attachment security to mothers and fathers. The *additive-hierarchical* hypothesis assumes that secure attachment to mothers will yield better outcomes than secure attachment to fathers, whereas the *additive-horizontal* hypothesis

assumes that secure attachment to mothers will yield equivalent outcomes to secure attachment to fathers. Two additional hypotheses (*buffering-hierarchical, buffering-horizontal*) propose that having at least one secure attachment yields better outcomes than having no secure attachments, but the *buffering-hierarchical* and *buffering-horizontal* hypotheses differ on importance of attachment security to fathers and mothers. The *buffering-hierarchical* hypothesis posits that having one secure attachment to mothers, but not fathers, yields equivalent beneficial outcomes to having a secure attachment to both parents. In contrast, the *buffering-horizontal* hypothesis proposes that having only one secure attachment to either mothers or fathers will result in equally beneficial outcomes to having secure attachments to both parents.

Few studies can address these hypotheses directly because few have assessments of the infant's attachments to both mother and father in the first year. The current study is an exception and offers a unique opportunity to test these various hypotheses of the effects of multiple attachment relationships on infant stress physiology. Although some researchers have argued that the SSP may not be as appropriate to measure father-attachment security because fathers are not typically primary caretakers and therefore do not serve as a safe haven for infants (Grossmann, Grossmann, Huber, & Wartner, 1981; Paquette & Bigras, 2010), substantial numbers of studies have now used the SSP to assess infant-father attachment security (Belsky & Rovine, 1988; Braungart-Rieker et al., 1999; Brock & Kochanska, 2018; Brown, Schoppe-Sullivan, Mangelsdorf, & Neff, 2010; Cox, Owen, Henderson, & Margand, 1992; Diener, Mengelsdorf, McHale, & Frosch, 2002; Grossmann et al., 2002; Lamb, Hwang, Frodi, & Frodi, 1982; Sagi et al., 1985; Tharner et al., 2012; Volling & Belsky, 1992). Because the SSP remains the gold standard measure of the infant' attachment security to both mothers and fathers, we used the SSP in our study.

Attachment security and early stress reactivity

Attachment theory posits that secure infant-parent attachment relationships are foundational for children's psychological and physiological functioning by (1) providing a safe haven, wherein infants rely on caregivers for comfort at times when they feel frightened, threatened,

or stressed; and (2) a secure base, from which they can explore the world and learn about the environment (Bowlby, 1988; Cassidy, Jones, & Shaver, 2013). Because infants use caregivers to regulate their distress under threatening conditions, the quality of early attachment relationships can guide biobehavioral responses to threat, including infant stress reactivity and emotion regulation (Dagan & Sagi-Schwartz, 2018; Diamond, Simpson, & Rholes, 2015). Although there are two major stress response systems, the hypothalamic-pituitary – adrenal (HPA) axis, which releases cortisol, and the sympathetic-adrenomedullary system, which releases epinephrine and norepinephrine, developmental researchers have focused primarily on cortisol and the HPA axis because cortisol can cross the blood-brain barrier, whereas norepinephrine and epinephrine do not (Gunnar, Doom, & Esposito, 2015). Stressful experiences stimulate the hypothalamus to release corticotropin-releasing factor, which, in turn, stimulates the anterior pituitary gland to release adrenocorticotropic hormone after cortisol is released from the adrenal glands. Cortisol then acts on tissues throughout the body, including the brain, and this bioenvironmental feedback loop (between stressful experiences and cortisol release) then serves to shape development (Gunnar et al., 2015). Indeed, numerous studies have examined the connections between parent-infant relationship experiences and infant cortisol reactivity, including the quality of infant-mother attachment. Most of these studies rely on the Strange Situation Procedure, (SSP) (Ainsworth, Blehar, Waters, & Wall, 1978) because parental separation is a developmentally-appropriate stressor for infants that often increases cortisol levels, and the SSP has a series of separations and reunions with the parent (Goldberg et al., 2003; Jansen, Beijers, Riksen-Walraven, & de Weerth, 2010; Laurent, Ablow, & Measelle, 2012). In addition, the SSP is also an assessment tool for measuring individual differences in secure and insecure infant-parent attachment relationships (i.e., secure, insecure-avoidant, insecure- ambivalent, insecure-disorganized), providing both the means for assessing attachment security and stress responses.

A number of studies have now examined relations between attachment security to mothers and infant cortisol reactivity during the SSP, but the findings are not consistently replicated (Beijers, Riksen-Walraven, & de Weerth, 2013; Gunnar, Brodersen, Nachmias, Buss, & Rigatuso, 1996; Nachmias, Gunnar, Mangelsdorf, Parritz, & Buss, 1996).

Gunnar et al. (1996) reported that insecure infants had greater increases in cortisol from pre-SSP to after the last reunion of the SSP than secure infants (N = 73), whereas Beijers et al. (2013) reported a near significant effect ($p < .10$), with insecure infants' higher post-SSP cortisol levels compared to secure infants (N = 193). Nachmias et al. (1996) reported no significant differences between secure and insecure infants on post-SSP cortisol levels (N = 77). These inconsistent findings are probably due to a number of issues, including sample size, how researchers chose to examine attachment effects, how many saliva samples were collected, at what point the saliva sample was collected, and the analysis strategy used to model cortisol reactivity. For instance, attachment classifications have frequently been collapsed into secure and insecure classifications (Beijers et al., 2013; Frigerio et al., 2009; Gunnar et al., 1996; Nachmias et al., 1996), whereas others have compared infants with organized (ABC) versus disorganized (D) attachments (Bernard & Dozier, 2010; Luijk et al., 2010), or considered each of the different attachment classifications separately for A (avoidant), B (secure), C (resistant), and D (disorganized) (Hertsgaard, Gunnar, Erickson, & Nachmias, 1995; Luijk et al., 2010; Spangler & Grossmann, 1993; Spangler & Schieche, 1998). Further, how studies assess and analyze cortisol varies considerably, with some using only a single post-SSP cortisol sample (Hertsgaard et al., 1995; Nachmias et al., 1996), others calculating change scores between pre- and post-SSP levels (Beijers et al., 2013; Gunnar et al., 1996; Luijk et al., 2010; Spangler & Grossmann, 1993), and still others, using individual pre- and post-SSP cortisol levels as a repeated factor of time in analyses (Bernard & Dozier, 2010; Gunnar, Mangelsdorf, Larson, & Hertsgaard, 1989).

In the current investigation, saliva samples were collected three times using the same laboratory protocol for mothers and fathers during separate laboratory visits. This design allowed a one-to-one comparison of infant cortisol reactivity in response to the same stressful procedure, used once with mothers and once with fathers. Further, repeated collections of saliva allowed an examination of whether infant cortisol trajectories differed as a function of the family configuration of attachment relationships. A normative cortisol reactivity response would include an increase in response to the stressor and then a subsequent decrease as time elapses after the stressor (Dickerson & Kemeny, 2004). Beyond the expected increase (reactivity) and decrease

(recovery) of cortisol in response to a stressor, there is some debate within the literature as to what constitutes abnormal or dysregulated cortisol reactivity (Gunnar et al., 2015). Abnormal cortisol output can take the form of hyperreactivity (stably high levels), or blunted cortisol release, in which cortisol declines in response to stress instead of increases (Diamond et al., 2015; Miller et al., 2013). Laboratory investigations of cortisol reactivity to stressors have found normative reactivity and regulation, as well as abnormal hyperreactivity and blunted cortisol patterns (Colich, Kircanski, Foland-Ross, & Gotlib, 2015; Hankin, Badanes, Abela, & Watamura, 2010; Miller et al., 2013). Thus it is possible that the patterns of cortisol change (increase-decrease, stable high, blunted) may also differ based on the configuration of secure or insecure attachment to both parents.

Previous research on infant cortisol and infant-mother attachment security used higher cortisol levels, or greater increases, as a benchmark for poorer functioning (Gunnar et al., 1996, 1989; Hertsgaard et al., 1995; Nachmias et al., 1996; Spangler & Grossmann, 1993). Because no prior study has addressed cortisol reactivity from a family-level perspective using SSP with mothers and fathers, the analyses presented here are naturally exploratory. Using Dagan and Sagi-Schwartz's theoretical framework, however, we developed four competing hypotheses based on different attachment models of influence and patterns of cortisol noted earlier. If the *additive-horizontal* hypothesis was supported, infants with two insecure attachments would have higher cortisol and atypical reactivity than those infants with one insecure attachment (either mother or father), who, in turn, would have higher cortisol and a more atypical reactivity pattern than infants with two secure attachments. If the *additive-hierarchical* hypothesis was supported, then infants with a secure attachment to mothers, but not fathers, would have lower cortisol and a more normative cortisol reactivity response than infants with only a secure attachment to fathers and infants with no secure attachments. If the *buffering-horizontal* hypothesis was supported, we would expect infants with at least one secure attachment to have lower cortisol levels and a more normative reactivity response than infants with two insecure attachments, but similar cortisol levels and reactivity patterns to those with two secure attachments because one secure attachment should be enough to buffer the stress response. Finally, if the *buffering-hierarchical* hypothesis was supported, in which attachment to only mothers yields

similarly beneficial outcomes to having a secure attachment with both parents, then infants with secure attachments only to mothers would have lower cortisol levels and a more normative reactivity response than infants with secure attachments only to fathers, and we would not see any differences between infants with secure attachments to both parents and infants with only a secure attachment to mother.

Methods

Study procedures

Data were from a sub-study of a larger longitudinal investigation of family functioning and child development after the birth of a second child (Volling et al., 2017) that was designed to assess changes in infant and parent hormones during the Strange Situation procedure and parent-child interaction. The main study consisted of five time points: prenatal (during mother's third trimester), and 1, 4, 8, and 12 months following the infant's birth, at which multiple methods (observations, couple interviews, child assessments, questionnaires) were used to assess multiple dimensions of child, parent, and family functioning. For complete details on recruitment and measures used for the larger investigation, please see (Volling et al., 2017). At the 12-month time point, parents and their second born infants participated in two counterbalanced laboratory visits (either 12 or 13 months) to assess infant-parent attachment security. The one-month spacing has been used in previous research using SSP with mothers and fathers (Braungart-Rieker et al., 1999; Volling & Belsky, 1992) in order to reduce emotional contagion of infant distress and memory of the procedure across visits. All parents remaining in the larger longitudinal study (*N* retained at 12 months = 203 of 241 recruited; 84%) were invited to participate in the hormone substudy and consented separately. Data for the current analyses included the 180 families who participated in the sub-study.

Each laboratory visit was the same across mothers and fathers and included an interview and warm-up session, the SSP, a small break in a waiting room to insure the infant was calm, before returning to the lab for a 15-minute teaching task (Vondra, Shaw, & Kevenides, 1995) to assess parent-infant interaction. After arrival to the laboratory, parents

were given instructions by a trained research assistant about the procedures of the visit and how to provide saliva samples. Experimenters collected saliva samples from infants in the presence of the parent by swabbing two absorbent hydrocelluose swabs (Sorbette, BD Opthalmic Systems) in the infant's mouth until swabs were saturated, approximately 60–90 seconds. During the initial interview in the waiting area, infants played on the floor nearby with a standard set of infant toys. Experimenters collected the first saliva sample from infants after this interview and before the infant and parent were escorted to the laboratory for the SSP; this sample served as the baseline value (Time 1). The second sample was timed and collected approximately 20 minutes after the first separation (Time 2) because of the relatively slow release of cortisol into saliva (Smyth, Hucklebridge, Thorn, Evans, & Clow, 2013), and generally coincided with the completion of the SSP and return to the waiting area. The third and final sample was timed and collected approximately 40 minutes after the first separation (Time 3), which usually occurred after the break and the 15-min teaching task. The timing of saliva collection was designed to assess a reactivity response (Time 1 to Time 2) to the first separation in the SSP, as well as a recovery response (Time 2 to Time 3). Although we attempted to schedule visits in the afternoon, due to scheduling availability of the families for laboratory visits, visit times ranged from 07:57 – 19:27 for fathers (M = 11:58 am, *SD* = 2:47), and 08:06 to 18:50 for mothers (*M* = 1:02 p.m., *SD* = 3:30). Time of day was entered as a control variable for all cortisol analyses. Saliva samples were frozen at −20°C after all samples were collected and transferred for storage at −80°C prior to assay.

Participants

Participants were 180 1-year old second-born infants (99 boys) and their parents. The mean age for mothers was 31.89 years (SD = 3.87), and for fathers was 33.35 years (SD = 4.60). The mean length of marriage was 5.78 years (SD = 2.62). Parents' household income ranged from $20,000 per year to more than $100,000 per year; 61% of the sample earned less than $99,999. Mothers and fathers were well educated; 88.3% of mothers earned a Bachelor's degree or higher, and 83.4% of fathers earned a Bachelor's degree or higher. The majority of mothers and fathers identified as White/European American (87.8%

of mothers, 88.3% of fathers), with 12.2% of mothers and 11.7% of fathers representing other racial and ethnic groups (See Volling et al., 2017, for full demographic description and sampling details). At 12 months, 74.2% of mothers reported working at least part-time, (*M*= 30.38 hours/week, *SD* = 15.00), and most (93.3%) of fathers reported working full-time, (*M* = 45.80 hours/week, *SD* = 11.85). Couples reported that infant care was usually the mothers' responsibility, across all four time points (at infant age 1, 4, 8, and 12 months), indicating that mothers provided more care, in general, than fathers. A total of 169 infants had attachment data with both parents, and 144 had sufficient saliva for cortisol assays from at least one time point. Missing cortisol data were due to low sample volume, difficulty obtaining samples from infants, or saliva samples available for visits with one parent but not the other.

Strange situation procedure and coding

The SSP (Ainsworth et al., 1978) is the gold-standard for assessing parent-infant attachment security at the end of the first year, and consists of seven, 3-minute episodes including two separations and two reunions. All SSP were video-recorded and coding was completed by trained independent and professional coders. Each SSP was coded for attachment security by a professional coding group, who were blinded to all other information about the participants. Infants were assigned an attachment classification of secure (B), insecure-avoidant (A), or insecure-resistant (C), and also coded as disorganized (D) or non-Disorganized). All cases initially coded as unclassifiable (U) were reviewed by the principal investigator and another independently trained rater, and given a secondary ABC classification that was used in the current analyses. The distribution of infant-mother attachment was as follows: A (*n* = 9, 5.3%), B (*n* = 112, 66.3%), C (*n* = 38, 22.5%), and D (*n* = 10, 5.9%). The distribution for infant-father attachment was A (*n* = 19, 11.2%), B (*n* = 106, 62.7%), C (*n* = 28, 16.6%), and D (*n* = 16, 9.5%). Attachment configurations were created by using the insecure (A, C, D) and secure (B) designations to create four groups: secure to both parents (n = 74), insecure to both parents (n = 25), secure tom other only (n = 38), and secure to father only (n = 32). See Supplementary Table 1 for a breakdown of ABCD classifications by attachment configuration.

Inter-rater reliability was calculated on 10.5% of the sample using Cohen's kappa (Cohen, 1960). Kappa reliability across mothers and fathers for secure and insecure categories was .71, reliability for mothers alone was excellent, kappa = .82, and reliability for fathers alone was substantial, kappa = .64.

Cortisol assays and analysis

Unstimulated infant saliva samples were thawed and extracted from hydrocellulose absorbent swabs and expressed into 2-mL cryogenic storage vials using centrifugation prior to assay. All samples from each infant (mother and father sessions) were assayed together for salivary cortisol using a highly sensitive enzyme immunoassay (Salimetrics, State College, PA). Samples were assayed in duplicate and the average of the duplicates was used in analyses. Samples with low sample volume were assayed in single wells. Intra- assay and inter-assay coefficients of variation were on average, 11.0% and 18.78% respectively. Cortisol values were log-transformed to correct for positive skew.

Results

Preliminary analyses

Descriptive statistics (means and standard deviations) for each of the three cortisol samples by attachment configuration and parent visit can be found in **Table 1**. Infant-mother attachment security has been explored in relation to maternal employment in some studies (Brooks-Gunn, Han, & Waldfogel, 2010; Harrison & Ungerer, 2002), and a one-way ANOVA indicated that there was a significant difference in mothers' work hours at 12 months by attachment group, $F(3,125) = 3.367$, $p < .05$. *Post hoc* Tukey pairwise comparisons revealed that infants with secure attachments to fathers, but not mothers, had mothers who worked significantly more hours per week (M = 37.77, SE = 2.77) than infants securely attached to mothers, but not fathers (M = 26.47, SE = 3.09), $p < .05$. Thus, mothers' work hours was included as a covariate in subsequent analyses.

Table 1. Descriptive statistics (Means and standard deviations) for cortisol levels by attachment configuration.

	Infant-Father Visit M(SD)			*Infant-Mother Visit M(SD)*		
	Baseline	*After SSP*	*After TT*	*Baseline*	*After SSP*	*After TT*
Insecure Both	.16(7.55)	.19(5.48)	.16(6.41)	.11(2.54)	.15(2.45)	.10(1.94)
Secure Dad Only	.19(5.44)	.19(4.10)	.16(5.86)	.24(4.75)	.13(3.79)	.21(5.55)
Secure Mom Only	.10(2.73)	.16(3.11)	.08(3.27)	.08(2.01)	.08(2.00	.08(2.21)
Secure Both	.10(2.15)	.10(2.64)	.09(2.41)	.11(2.83)	.12(2.38)	.12(2.19)

Means and standard deviations are re-transformed from log-transformed values and appear in µg/dL.
SSP = Strange Situation Procedure, TT = Teaching Task

Patterns of cortisol reactivity

We conducted a 3(time) x 4(attachment configuration: secure to both, secure to mother, secure to father, insecure to both) x 2(parent: mother, father) mixed effects model with a heterogeneous first-order autoregressive covariance matrix to address our first question of whether patterns of infant cortisol reactivity across the lab visit differed by attachment configuration. Time (i.e., baseline, post-SSP, post-Teaching Task), parent, and attachment configuration were modeled as categorical fixed effects. Time was modeled as a categorical fixed effect to test for non-linear patterns of cortisol reactivity as would be expected (e.g., increase and then decline). Counterbalancing was included as a categorical covariate and time of day and mothers' work hours were included as continuous covariates. The model included the following interactions as fixed effects: Time x Attachment Configuration, Time x Parent, and Attachment Configuration x Parent, and the three-way interaction among Time x Parent x Attachment Configuration. We were primarily interested in the interactions involving attachment configuration and time to be able to test our hypotheses. A random effect of infant (i.e., random effect of intercept) was included to account for the dependencies in the data, as these were the same infants who participated across infant-mother and infant-father visits. Missing data were handled by using a restricted information maximum likelihood estimation and a Bonferroni correction was applied to adjust for multiple comparisons for main effects. Due to small cell sizes, Bonferroni corrections were not applied to the interaction effects.

There were no significant main effects of attachment configuration, parent, or counterbalancing on infant cortisol levels, *p*'*s* > .12. The Time effect (baseline, post-SSP, post-teaching task) approached statistical significance $F(2,201.39) = 2.83$, $p = .06$. There was also a significant effect of time of day, $F(1,180.98) = 5.38$, $p = .02$ which was expected, given that cortisol follows a diurnal rhythm in which cortisol levels rise in the morning and peak 30 minutes after waking, and then decline throughout the day (Tryphonopoulos, Letourneau, & Azar, 2014). We did not find that infant cortisol levels significantly varied based on counterbalancing (whether it was the infant's first or second visit) or mothers' work hours. The attachment configuration x parent interaction ($p = .36$), and the three-way interaction between attachment configuration, time, and parent ($p = .08$) were nonsignificant. Subsequent reporting of cortisol means and standard errors are re-transformed to µg/dL from natural-logged values included in analyses to ease interpretation of effects.

There were two significant two-way interactions. The first was time x parent, $F(2, 201.84) = 3.80$, $p = .02$, indicating that infant cortisol reactivity across the visit differed by whether the infant was accompanied to the lab by the mother or father. To probe the significant time x parent interaction, we conducted *post hoc* least squares differences pairwise comparisons. Infants had significantly higher cortisol levels post-SSP with their fathers, $p = .028.$,$M = .16$, $SE = 1.14$, than with their mothers, $M = .11$, $SE = 1.14$. During visits with fathers, infants also had significantly higher cortisol levels post-SSP compared to post-teaching task, $p = .001$, $M = .11$, $SE = 1.15$.

Hypothesis testing: does infant cortisol reactivity co-vary with attachment configuration?

There was a significant time x attachment configuration interaction effect, $F(6, 201.72) = 4.34$, $p < .001$, indicating that infant cortisol reactivity was moderated by attachment configuration. The time x attachment configuration patterns of infant cortisol reactivity are depicted in **Figure 1**. *Post hoc* least squares differences pairwise comparisons of the time x attachment configuration interaction revealed both significant within-time point, between-group comparisons, and within-group, between-time point comparisons (see **Table 2** for summary of

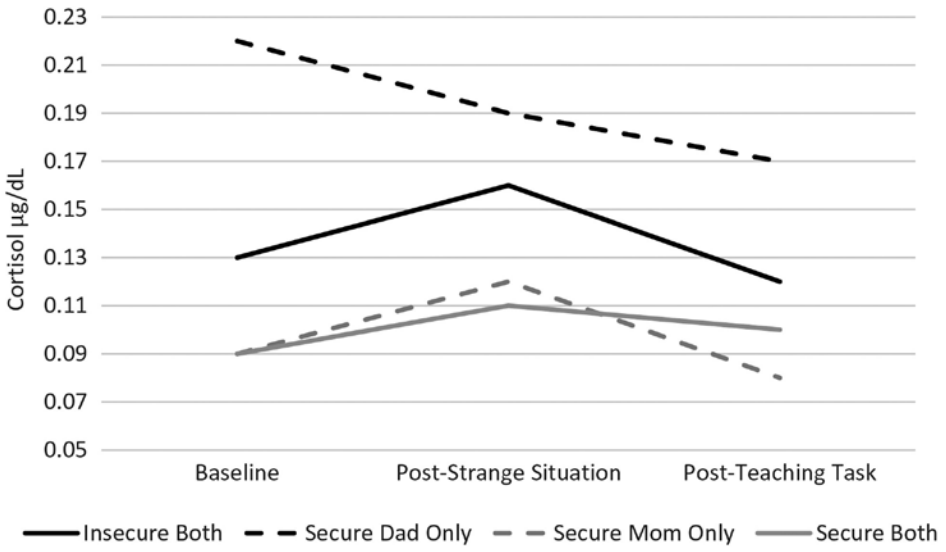

Figure 1. Cortisol response patterns for infants by attachment configuration.

Table 2. Attachment configuration x time interaction for cortisol means and standard errors.

Attachment Configuration	*Baseline M (SE)*	*After SSP M (SE)*	*After TT M (SE)*
Insecure Both	.13 (1.27)	.16 (1.27)	.12 (1.29)
Secure Dad Only	[1].21a (1.26)	.13b (1.26)	[1].16 (1.28)
Secure Mom Only	[2].09a (1.23)	.13b (1.23)	[2].08a (1.25)
Secure Both	[2].09 (1.16)	.10 (1.15)	.10 (1.16)

* $p < .05$

Unique lettered subscripts indicate significant within-group, between timepoint differences at $p < .05$. Unique numbered superscripts indicate significant between-group, within timepoint differences at $p < .05$.

Cortisol values are retransformed from natural log values and are in µg/dL.

SSP = Strange Situation Procedure, TT = Teaching Task

means and standard errors). Evaluating cortisol level differences allowed us to examine which of the competing hypotheses (additive-horizontal, additive-hierarchical, buffering-horizontal, buffering hierarchical) were best supported by the findings. Infants securely attached only to fathers had significantly higher baseline cortisol $M = .21$, $SE = 1.26$, than infants securely attached only to mothers, $p = .005$, $M = .09$, $SE = 1.23$, and infants securely attached to both parents, $p = .001$,

M = .09, *SE* = 1.16. Further, infants securely attached only to fathers continued to have higher cortisol levels post-teaching task (Time 3) than infants securely attached only to mothers $p = .03$. These findings appear to support the buffering-hierarchical hypothesis, as infants with secure attachments to their mothers had lower cortisol levels, even when they had insecure attachments to their fathers, than infants with a secure attachment to their fathers only.

When examining cortisol reactivity across time for each group, we found that infants securely attached only to fathers showed a significant decline in cortisol from baseline, $p = .005$, *M* = .21, *SE* = 1.26, to post-SSP, *M* = .13, *SE* = 1.26, with no further change from post-SSP to post-teaching task, $p = .36$, *M* = .16, *SE* = 1.28; a pattern reflecting a blunted cortisol response (Diamond et al., 2015; Miller et al., 2013). In contrast, infants securely attached only to mothers showed a significant increase in cortisol from baseline, *M* = .09, *SE* = 1.23, to post-SSP, $p = .008$, *M* = .13, *SE* = 1.23, and a significant decline by Time 3, the post-teaching task, $p = .001$, *M* = .08, *SE* = 1.25 – indicative of a typical pattern of cortisol reactivity and regulation in response to a stressor (Gunnar et al., 2015).

Post-hoc exploratory analyses

The findings that infants with a secure attachment to fathers, but not mothers, exhibited a blunted cortisol reactivity response that is reflective of chronic stress, were unexpected. Not only is their reactivity pattern unique, but these infants had also come to the laboratory with elevated baseline levels of cortisol. Why would infants with a secure attachment to fathers, but not mothers, appear to be chronically stressed? In an attempt to uncover what infant, parent, or family factors might explain this pattern, we conducted a series of post-hoc exploratory analyses to uncover potential sources of stress in the family system that may have been related to the development of the different attachment configurations (secure both, insecure both, secure to only father, secure to only mother), and, in turn, shaped the infants' cortisol response. In line with both a family systems perspective and Belsky's determinants of parenting model (Belsky, 1984), we chose parent, infant, and family variables that have been related to experiences of chronic stress and attachment security in prior research (Atkinson

et al., 2000; Lucassen et al., 2017; Owen & Cox, 1997; Vaughn, Lefever, Seifer, & Barglow, 1989). Specifically, we chose mothers' and fathers' depressive symptoms (21 items; $\alpha_{mother} = .81$, $\alpha_{father} = .84$) using the Beck Depression Inventory (Beck, Ward, Mendelson, Mock, & Erbaugh, 1961), mothers' and fathers' reports of marital conflict (5 items; $\alpha_{mother} = .73$, $\alpha_{father} = .72$) using the Intimate Relations Questionnaire (Braiker & Kelley, 1979), and fussy-difficult infant temperament (9 items; $\alpha_{mother} = .85$, $\alpha_{father} = .84$) using the infant characteristics questionnaire (Bates, Claire, & Lounsbury, 1979) for these analyses. Parents reported on their depression and marital conflict at 12 months, and both parents reported on the infants' difficult temperament at 8 months. Mothers' and fathers' ratings of infant temperament were positively correlated ($r = .61$, $p < .001$), and thus a composite score based on averaging both parents' reports was used for the difficult infant temperament variable.

We conducted a multinomial logistic regression to examine whether the infants with a secure attachment only to fathers could be distinguished from the other attachment configuration groups based on marital conflict, parental depression, and difficult infant temperament. Infants who were securely attached to fathers only had mothers who reported more marital conflict at 12 months compared to mothers of infants who were securely attached to both parents (Wald = 8.38, B = −.61, $p = .004$). No other variables in the model (parent depression, fathers' reports of marital conflict, and infant difficult temperament) showed statistically significant effects.

Discussion

The current study represents a step forward in understanding how the family configuration of infant attachment security to both mothers and fathers may shape infant stress reactivity. Using recent conceptual formulations by Dagan and Sagi-Schwartz (2018) on the configuration of the network of attachment relationships infants have with more than one caregiver, we were able to test directly the additive-hierarchical, additive-horizontal, buffering- hierarchical, and buffering-horizontal hypotheses of the effects of none, one, or two secure attachments, and whether attachment security to mother mattered more than attachment security to father. This study focused specifically on

infant cortisol reactivity and regulation in response to a stressor, here the separations of the SSP, and it should be noted that the findings may be unique to stress reactivity under these conditions, and should not be generalized to other infant outcomes.

As hypothesized, infants securely attached to both parents had some of the lowest levels of cortisol as an index of stress, and also showed no significant change in cortisol over time. Similarly, infants insecurely attached to both parents had higher levels of cortisol than infants securely attached to both parents, and infants securely attached only to mothers, but these differences were not significant. The results also revealed some striking, and somewhat unexpected, differences in infant's stress reactivity, when comparing families in which infants were securely attached only to mothers with families in which infants were securely attached only to fathers. Specifically, infants securely attached to mothers but not fathers showed a typical stress reactivity and regulation response, with an increase from baseline (Time 1) to post-SSP (Time 2), and decrease from post-SSP to post-teaching task (Time 3). In contrast, infants securely attached only to fathers but not mothers showed an atypical, dysregulated and blunted stress response, with the highest baseline cortisol levels that declined in response to the SSP. Because no prior study has examined infant stress reactivity and regulation from an attachment network perspective using SSP with mothers and fathers, the current findings are considered preliminary based on exploratory analyses, and further research is certainly needed to replicate these findings in the future. Until then, we discuss how these results fit with Dagan and Sagi-Schwartz's (2018) recent theoretical framework of the attachment network, and offer suggestions as to why such different reactivity patterns may have emerged for families in which infants had either secure or insecure attachments with their mothers and fathers.

Is one secure attachment enough?

According to Dagan and Sagi-Schwartz (2018), having information on infant-mother and infant-father attachment allows one to address two developmental questions that research focused on only one attachment relationship does not: (1) Does the number of secure attachments (zero, one, or two) matter, and (2) Is attachment security with one parent (mother or father) associated differently with the child's

stress response than attachment security with the other parent? Regarding the first question, our findings do not support an additive hypothesis (either hierarchical or horizontal) because having at least one secure attachment did not appear to buffer infants from dysregulated cortisol reactivity or higher cortisol levels. There were no significant between-group differences in cortisol levels at any time point between infants insecurely attached to both parents and infants with at least one secure attachment, although it did seem to matter with whom the infant had a secure attachment; a point we return to momentarily.

One of the most surprising and unexpected findings was that there were no significant differences in cortisol levels or reactivity patterns between the infants with two secure attachments compared to the infants with two insecure attachments, even though infants in the latter group did have higher cortisol levels. Previous studies on cortisol stress reactivity have found that social-evaluative threats, particularly when coupled with unpredictability or uncontrollability of the threat, can elicit a cortisol response (Dickerson & Kemeny, 2004; Gunnar et al., 2015). Because these infants had concordant attachments (either both secure or both insecure) to their mothers and fathers, their overall caregiving experiences with their parents may have been quite similar, either predictably sensitive and reliable (in the case of both secure) or predictably insensitive and unreliable (in the case of both insecure). Thus, although caregiving histories may differ widely for infants, leading to divergent attachment security, the predictability and consistency in caregiving across parents may account for the lack of differences in cortisol reactivity for both family groups. Further, because the development of an insecure attachment working model is an adaptive response to an insensitive caregiving environment (Simpson & Belsky, 2008), these infants may have developed adaptive stress responses as well. Alternatively, the number of families in which infants had insecure attachments to both parents was quite small (n = 25), and comparisons may have been underpowered to identify any significant differences in reactivity patterns. This possibility is supported, in part, by the pattern of findings in that infants with insecure attachments to both parents did have higher cortisol levels at all three time points than infants with secure attachments to both parents, and infants securely attached only to mothers, although the differences were not statistically significant. Future research that includes information on infant-father and infant-mother attachment with larger sample sizes

is needed to assess fully whether infants with insecure attachments to both parents do or do not exhibit significantly greater cortisol responses to separation in the SSP.

Does it matter if the secure attachment is to mother or father?

Regarding Dagan & Sagi-Schwartz's second question of whether the attachment to one parent contributes more to developmental outcomes than the other parent, the answer is a bit more complex. The results showed clear support for the buffering-hierarchical hypothesis; infants with a secure attachment to mother had a more optimal cortisol reactivity response than infants with only a secure attachment to father. Infants securely attached only to fathers showed significant declines from elevated baselines, whereas the infants securely attached only to mothers showed significant increases in response to separation stress that eventually subsided, which is the expected response to a stressor (Gunnar et al., 2015). In contrast, cortisol declines in response to stressors have been identified as a non-normative HPA response and seen in populations with chronic stress (Diamond et al., 2015; Miller et al., 2013). These blunted cortisol responses, or declines from elevated baselines, are interpreted as potentially adaptive to protect the brain from sustained stress-related exposure to cortisol (Miller, Chen, & Parker, 2011). Through this lens, then, infants securely attached to only one parent appeared to have more normative stress reactivity when that secure attachment was with the mother.

Yet, is the question really who matters more – mother or father? Or is the point of creating family configurations of the attachment network to uncover the ecological context of relationships infants have with multiple caregivers, and what this means for the infant's health and well-being? To be clear, here, these configurations of security or insecurity with one or both parents are based on a caregiving history over the first year of these second-born infants' lives. It is not simply a matter of whether the infant has a secure attachment to father and not mother, but what family circumstances over the year gave rise to this family configuration, because those same circumstances may also tell us why infants developed the stress responses observed in the SSP. Why would an infant have a secure attachment to their father and not their mother, and in turn, the dysregulated, blunted cortisol reactivity response? In our post-hoc family stress analyses, we found

that these infants had mothers who reported greater marital conflict at 12 months when the SSP was conducted. Perhaps the confluence of multiple factors in the family gives rise to the insecure mother-secure father family configuration and infants' stress regulation. The demands of work-family stress in a family system with both parents balancing caregiving of two children leading to marital conflict may stress the infants HPA axis and also perpetuate children' growing sense of emotional insecurity within the family (Cummings & Davies, 2010). Dysregulated cortisol responses may reflect the initial underpinnings of the infants' sense of vulnerability and a defense against interpersonal threat and interparental discord (Davies & Martin, 2013). Future research could investigate the co-development of infant attachment security to both parents, emotional security in the interparental dyad, and infant stress regulation.

Limitations

Although findings offer a unique perspective on the role of early experience on infant stress reactivity, there are also limitations that need to be noted. The results may be due, in part, to the different ratios of insecurity (avoidant resistant, disorganized) in the two discordant groups. For infants secure only to fathers, 68.8% were insecure-resistant with mothers, 15.6% were insecure-avoidant, and 15.6% were disorganized. For infants secure only to mothers, 42.1% were insecure-resistant to fathers, 36.8% were insecure-avoidant, and 21.1% were insecure-disorganized (see supplementary materials). Given that the majority of infants securely attached only to fathers had insecure-resistant attachments to their mothers, the dysregulated cortisol response may reflect the greater number of insecure-resistant infants, as these infants typically express the most emotional distress during the Strange Situation (Leerkes & Wong, 2012). Variation in cortisol reactivity may differ depending on the sub-classifications of insecure attachments, but the current study is underpowered to address this question completely. Rarely are sample sizes large enough to examine the different subgroups of insecure infants, but theoretically, insecure- resistant and insecure-avoidant infants have different responses to emotionally eliciting situations and different patterns of emotion dysregulation (Cassidy, 1994; Diener et al., 2002; Martins, Soares, Martins, Tereno, & Osório, 2012). Future research may be able to clarify

these differences further. It also needs to be noted that all infants in this sample were second born children, whose parents and older siblings were participating in a longitudinal investigation of child and family adjustment to the birth of a sibling (Volling et al., 2017). The caregiving environments of these infants in their first year, in which mothers and fathers are balancing the needs of two young children, are clearly different from the parenting experiences in the first year of firstborn infants, and this may play some role in the development of infant-mother and infant-father attachments for these infant siblings, albeit a recent study found no significant associations between number of siblings and infant-mother attachment security (Bernier, Miljkovitch, Tarabulsy, Sirois, & Bailey, 2018). Finally, the sample consisted of opposite-sex couples from middle class circumstances, who were predominantly white. We do not know if these results would replicate in more racially and socioeconomically diverse families, or in same-sex couples.

Conclusion

Attachment researchers have long focused on the developmental sequelae of the mother-infant attachment relationship (Groh et al., 2014; Howes & Spieker, 2008; Thompson, 2008), undoubtedly influenced by Bowlby's own thinking on the primacy of the mother-infant relationship (Bretherton, 1985). Despite growing interest in precursors to and outcomes stemming from father-infant attachment relationships (Belsky, 1996; Braungart-Rieker et al., 1999; Lickenbrock & Braungart-Rieker, 2015; Lucassen et al., 2011; Volling & Belsky, 1992), when father-infant attachment has been the focus, researchers often examine the independent contributions of attachment security to mothers and attachment security to fathers in predicting children's outcomes (Groh et al., 2014; Ranson & Urichuk, 2008). Few have adopted a network approach in examining how attachment relationships to mothers and fathers combine to shape children's development (Cowan, 1997). Dagan and Sagi-Schwartz (2018) have done a service to the field by providing a new framework to understand how the network of infant-mother and infant-father attachment configurations may shape children's development (Dagan & Sagi-Schwartz, 2018). The present study was the first investigation to examine infant attachment security to

both mothers and fathers in relation to infant cortisol reactivity, and as such, provides a basis from which to generate future hypotheses about infant stress reactivity and the family dynamics that give rise to infants' discordant attachments to their mothers and fathers. Given the importance of children's cortisol reactivity and regulation in response to stress for learning and memory (Thompson, Morgan, Jurado, & Gunnar, 2015; Thompson & Trevathan, 2008) as well as mental health (Davies, Sturge-Apple, & Cicchetti, 2011), our findings represent a potential mechanism between infant attachment relationships to mothers and fathers and children's subsequent emotional, social, and cognitive development.

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References

Ainsworth, M. D. S., Blehar, M. C., Waters, E., & Wall, S. (1978). *Patterns of attachment: A psychological study of the strange situation*. Hillsdale, NJ: Lawrence Erlbaum Associates; distributed by Halsted Press Division of Wiley.

Atkinson, L., Paglia, A., Coolbear, J., Niccols, A., Parker, K. C. H., & Guger, S. (2000). Attachment security: A meta-analysis of maternal mental health correlates. *Clinical Psychology Review*, *20*(8), 1019–1040.

Bates, J. E., Claire, A. B. F., & Lounsbury, M. L. (1979). Measurement of infant difficultness. *Child Development*, *50*(3), 794–803.

Beck, A. T., Ward, C. H., Mendelson, M. M., Mock, J., & Erbaugh, J. (1961). An inventory for measuring depression. *Archives of General Psychiatry*, *4*(6), 561–571.

Beijers, R., Riksen-Walraven, J. M., & de Weerth, C. (2013). Cortisol regulation in 12-month-old human infants: Associations with the infants' early history of breastfeeding and co-sleeping. *Stress*, *16*(3), 267–277.

Belsky, J. (1984). The determinants of parenting: A process model. *Child Development*, *55*(1), 83–96.

Belsky, J. (1996). Parent, infant, and social-contextual antecedents of father-son attachment security. *Developmental Psychology*, *32*(5), 905–913.

Belsky, J., & Rovine, M. J. (1988). Nonmaternal care in the first year of life and the security of infant-parent attachment. *Child Development*, *59*(1), 157–167.

Bernard, K., & Dozier, M. (2010). Examining infants' cortisol responses to laboratory tasks among children varying in attachment disorganization: Stress reactivity or return to baseline? *Developmental Psychology*, *46*(6), 1771–1778.

Bernier, A., Miljkovitch, R., Tarabulsy, G. M., Sirois, M.-S., & Bailey, H. N. (2018). Reconsidering the links between sibship size, maternal sensitivity, and child attachment: A multidimensional interactive approach. *Journal of Family Psychology*, *32*(3), 396–405.

Bowlby, J. (1988). *A secure base: Parent-child attachment and healthy human development*. New York, NY: Basic Books.

Braiker, H. B., & Kelley, H. H. (1979). Conflict in the development of close relationships. In R. L. Burgess & T. L. Huston (Eds.), *Social exchange in developing relationships* (pp. 135–168). New York: Academic.

Braungart-Rieker, J., Courtney, S., & Garwood, M. M. (1999). Mother– And father–Infant attachment: Families in context. *Journal of Family Psychology*, *13*(4), 535–553.

Bretherton, I. (1985). Attachment theory: Retrospect and prospect. *Monographs of the Society for Research in Child Development*, *50*, 3–35.

Bretherton, I. (2010). Fathers in attachment theory and research: A review. *Early Child Development and Care*, *180*(1–2), 9–23.

Brock, R. L., & Kochanska, G. (2018). Anger in infancy and its implications: History of attachment in mother–Child and father–Child relationships as a moderator of risk. *Development and Psychopathology*, 1–14. doi:10.1017/S0954579418000780

Brooks-Gunn, J., Han, W.-J., & Waldfogel, J. (2010). First-year maternal employment and child development in the first 7 years: V. First-year maternal employment and child social and emotional development. *Monographs of the Society for Research in Child Development*, *75*(2), 59–69.

Brown, G. L., Schoppe-Sullivan, S. J., Mangelsdorf, S. C., & Neff, C. (2010). Observed and reported supportive coparenting as predictors of infant-mother and infant-father attachment security. *Early Child Development and Care*, *180*(1–2), 121–137.

Cassidy, J. (1994). Emotion regulation: Influences of attachment relationships. *Monographs of the Society for Research in Child Development*, *59*(2–3), 228–283.

Cassidy, J., Jones, J. D., & Shaver, P. R. (2013). Contributions of attachment theory and research: A framework for future research, translation, and policy. *Development and Psychopathology*, *25* (4pt2), 1415–1434.

Cohen, J. (1960). A coefficient of agreement for nominal scales. *Educational and Psychological Measurement*, *20*(1), 37–46.

Colich, N. L., Kircanski, K., Foland-Ross, L. C., & Gotlib, I. H. (2015). HPA-axis reactivity interacts with stage of pubertal development to predict the onset of depression. *Psychoneuroendocrinology*, *55*, 94–101.

Cowan, P. A. (1997). Beyond meta-analysis: A plea for a family systems view of attachment. *Child Development*, *68*(4), 601–603.

Cox, M. J., Owen, M. T., Henderson, V. K., & Margand, N. A. (1992). Prediction of infant-father and infant-mother attachment. *Developmental Psychology*, *28*(3), 474–483.

Cummings, E. M., & Davies, P. T. (2010). *Marital conflict and children: An emotional security perspective*. New York: Guilford Press.

Dagan, O., & Sagi-Schwartz, A. (2018). Early attachment network with mother and father: An unsettled issue. *Child Development Perspectives*, *12*(2), 115–121.

Davies, P. T., & Martin, M. J. (2013). The reformulation of emotional security theory: The role of children's social defense in developmental psychopathology. *Development and Psychopathology*, *25*(4pt2), 1435–1454.

Davies, P. T., Sturge-Apple, M. L., & Cicchetti, D. (2011). Interparental aggression and children's adrenocortical reactivity: Testing an evolutionary model of allostatic load. *Development and Psychopathology*, *23*(3), 801–814.

Diamond, L. M., Simpson, J., & Rholes, W. (2015). Stress and attachment. In J. A. Simpson, W. S. Rholes (Eds.) *Attachment theory and research: New directions and emerging themes* (pp. 97-123). New York, NY: Guilford Press

Dickerson, S. S., & Kemeny, M. E. (2004). Acute stressors and cortisol responses: A theoretical integration and synthesis of laboratory research. *Psychological Bulletin*, *130*(3), 355–391.

Diener, M. L., Mengelsdorf, S. C., McHale, J. L., & Frosch, C. A. (2002). Infants' behavioral strategies for emotion regulation with fathers and mothers: Associations with emotional expressions and attachment quality. *Infancy*, *3*(2), 153–174.

Frigerio, A., Ceppi, E., Rusconi, M., Giorda, R., Raggi, M. E., & Fearon, P. (2009). The role played by the interaction between genetic factors and attachment in the stress response in infancy. *Journal of Child Psychology and Psychiatry*, *50*(12), 1513–1522.

Goldberg, S., Levitan, R., Leung, E., Masellis, M., Basile, V. S., Nemeroff, C. B., & Atkinson, L. (2003). Cortisol concentrations in 12- to 18-month-old infants: Stability over time, location, and stressor. *Biological Psychiatry*, *54*(7), 719–726.

Groh, A. M., Fearon, P., Bakermans-Kranenburg, M. J., van Ijzendoorn, M. H., Steele, R. D., & Roisman, G. I. (2014). The significance of attachment security for children's social competence with peers: A meta-analytic study. *Attachment & Human Development*, *16*(2), 103–136.

Grossmann, K., Grossmann, K. E., Fremmer-Bombik, E., Kindler, H., Scheuerer-Englisch, H., & Zimmermann, P. (2002). The uniqueness of the child-father attachment relationship: Fathers' sensitive and challenging play as a pivotal variable in a 16-year longitudinal study. *Social Development*, *11*(3), 307–331.

Grossmann, K., Grossmann, K. E., & Kindler, H. (2005). Early care and the roots of attachment and partnership representations. In K. E. Grossmann, K. Grossmann, & E. Waters (Eds.), *Attachment from infancy to adulthood: The major longitudinal studies* (pp. 98–136). New York: The Guilford Press.

Grossmann, K., Grossmann, K. E., Kindler, H., & Zimmermann, P. (2008). *A wider view of attachment and exploration: The influence of mothers and fathers on*

the development of psychological security from infancy to young adulthood handbook of attachment: Theory, research, and clinical applications (*2nd* ed., pp. 857–879). New York, NY: Guilford Press.

Grossmann, K. E., Grossmann, K., Huber, F., & Wartner, U. (1981). German children's behavior towards their mothers at 12 months and their fathers at 18 months in Ainsworth's strange situation. *International Journal of Behavioral Development*, *4*(2), 157–181.

Gunnar, M. R., Brodersen, L., Nachmias, M., Buss, K., & Rigatuso, J. (1996). Stress reactivity and attachment security. *Developmental Psychobiology*, *29*(3), 191–204.

Gunnar, M. R., Doom, J. R., & Esposito, E. A. (Eds.). (2015). In R. M. Lerner, M. E. Lamb (Eds.) *Psychoneuroendocrinology of stress: Normative development and individual differences* (Vol. 3, 7 ed.). Hoboken, NJ: John Wiley & Sons.

Gunnar, M. R., Mangelsdorf, S., Larson, M., & Hertsgaard, L. (1989). Attachment, temperament, and adrenocortical activity in infancy: A study of psychoendocrine regulation. *Developmental Psychology*, *25*(3), 355–363.

Hankin, B. L., Badanes, L. S., Abela, J. R. Z., & Watamura, S. E. (2010). Hypothalamic–Pituitary– Adrenal axis dysregulation in dysphoric children and adolescents: Cortisol reactivity to psychosocial stress from preschool through middle adolescence. *Biological Psychiatry*, *68*(5), 484–490.

Harrison, L. J., & Ungerer, J. A. (2002). Maternal employment and infant-mother attachment security at 12 months postpartum. *Developmental Psychology*, *38*(5), 758–773.

Hertsgaard, L., Gunnar, M., Erickson, M. F., & Nachmias, M. (1995). Adrenocortical responses to the strange situation in infants with disorganized/disoriented attachment relationships. *Child Development*, *66*(4), 1100–1106.

Howes, C., & Spieker, S. (Eds.). (2008). Attachment relationships in the context of multiple caregivers. In I J. Cassidy & PR Shaver (Red.), *Handbook of attachment: Theory, research, and clinical applications* (pp. 317–332). New York: The Guildford Press.

Jansen, J., Beijers, R., Riksen-Walraven, M., & de Weerth, C. (2010). Cortisol reactivity in young infants. *Psychoneuroendocrinology*, *35*(3), 329–338.

Lamb, M. E., Hwang, C. P., Frodi, A. M., & Frodi, M. (1982). Security of mother- and father-infant attachment and its relation to sociability with strangers in traditional and nontraditional Swedish families. Infant behavior and development, 5(2-4), 355–367.

Laurent, H. K., Ablow, J. C., & Measelle, J. (2012). Taking stress response out of the box: Stability, discontinuity, and temperament effects on HPA and SNS across social stressors in mother–Infant dyads. *Developmental Psychology*, *48*(1), 35–45.

Leerkes, E. M., & Wong, M. S. (2012). Infant distress and regulatory behaviors vary as a function of attachment security regardless of emotion context and maternal involvement. *Infancy*, *17*(5), 455–478.

Lickenbrock, D. M., & Braungart-Rieker, J. M. (2015). Examining antecedents of infant attachment security with mothers and fathers: An ecological systems perspective. *Infant Behavior & Development*, *39*, 173–187.

Lucassen, N., Tharner, A., Prinzie, P., Verhulst, F. C., Jongerling, J., Bakermans-Kranenburg, M. J., … Tiemeier, H. (2017). Paternal history of depression or anxiety disorder and infant–Father attachment. *Infant and Child Development*. doi:10.1002/icd.2070

Lucassen, N., Tharner, A., Van Ijzendoorn, M. H., Bakermans-Kranenburg, M. J., Volling, B. L., Verhulst, F. C., … Tiemeier, H. (2011). The association between paternal sensitivity and infant– Father attachment security: A meta-analysis of three decades of research. *Journal of Family Psychology*, *25*(6), 986–992.

Luijk, M. P. C. M., Saridjan, N., Tharner, A., van Ijzendoorn, M. H., Bakermans-Kranenburg, M. J., Jaddoe, V. W. V., … Tiemeier, H. (2010). Attachment, depression, and cortisol: Deviant patterns in insecure-resistant and disorganized infants. *Developmental Psychobiology*, *52*(5), 441–452.

Martins, E. C., Soares, I., Martins, C., Tereno, S., & Osório, A. (2012). Can we identify emotion overregulation in infancy? Associations with avoidant attachment, dyadic emotional interaction and temperament. *Infant and Child Development*, *21*(6), 579–595.

McKelley, R. A., & Rochlen, A. B. (2016). *Furthering fathering: What we know and what we need to know APA handbook of men and masculinities* (pp. 525–549). Washington, DC: American Psychological Association.

Miller, A. L., Clifford, C., Sturza, J., Rosenblum, K., Vazquez, D. M., Kaciroti, N., & Lumeng, J. C. (2013). Blunted cortisol response to stress is associated with higher body mass index in low-income preschool-aged children. *Psychoneuroendocrinology*, *38*(11), 2611–2617.

Miller, G. E., Chen, E., & Parker, K. J. (2011). Psychological stress in childhood and susceptibility to the chronic diseases of aging: Moving toward a model of behavioral and biological mechanisms. *Psychological Bulletin*, *137*(6), 959.

Nachmias, M., Gunnar, M. R., Mangelsdorf, S., Parritz, R. H., & Buss, K. (1996). Behavioral inhibition and stress reactivity: The moderating role of attachment security. *Child Development*, *67*(2), 508–522.

Owen, M. T., & Cox, M. J. (1997). Marital conflict and the development of infant–Parent attachment relationships. *Journal of Family Psychology*, *11*(2), 152–164.

Paquette, D., & Bigras, M. (2010). The risky situation: A procedure for assessing the father–Child activation relationship. *Early Child Development and Care*, *180*(1–2), 33–50.

Ranson, K. E., & Urichuk, L. J. (2008). The effect of parent–Child attachment relationships on child biopsychosocial outcomes: A review. *Early Child Development and Care*, *178*(2), 129–152.

Sagi, A., Lamb, M. E., Lewkowicz, K. S., Shoham, R., Dvir, R., & Estes, D. (1985). Security of infant– Mother, –Father, and –Metapelet attachments among kibbutz-reared Israeli children. *Monographs of the Society for Research in Child Development*, *50*(1–2), 257–275.

Sagi-Schwartz, A., & Aviezer, O. (2005). Correlates of attachment to multiple caregivers in kibbutz children from birth to emerging adulthood. In K. E. Grossmann, K. Grossmann, & E. Waters (Eds.), *Attachment from infancy to adulthood: The major longitudinal studies* (pp. 165–197). New York: The Guilford Press.

Simpson, J. A., & Belsky, J. (2008). Attachment theory within a modern evolutionary framework. In J. Cassidy & J. Shaver (Eds.), *Handbook of attachment: Theory, research, and clinical applications* (Vol. 2, pp. 131–157). New York: Guilford Press.

Smyth, N., Hucklebridge, F., Thorn, L., Evans, P., & Clow, A. (2013). Salivary cortisol as a biomarker in social science research. *Social and Personality Psychology Compass*, *7*(9), 605–625.

Spangler, G., & Grossmann, K. E. (1993). Biobehavioral organization in securely and insecurely attached infants. *Child Development*, *64*(5), 1439–1450.

Spangler, G., & Schieche, M. (1998). Emotional and adrenocortical responses of infants to the strange situation: The differential function of emotional expression. *International Journal of Behavioral Development*, *22*(4), 681–706.

Steele, H., & Steele, M. (Eds.). (2005). *Understanding and resolving emotional conflict*. New York: The Guilford Press.

Tharner, A., Luijk, M. P. C. M., van Ijzendoorn, M. H., Bakermans-Kranenburg, M. J., Jaddoe, V. W. V., Hofman, A., … Tiemeier, H. (2012). Infant attachment, parenting stress, and child emotional and behavioral problems at age 3 years. *Parenting*, *12*(4), 261–281.

Thompson, L. A., Morgan, G., Jurado, K. A., & Gunnar, M. R. (2015). A longitudinal study of infant cortisol response during learning events: Abstract. *Monographs of the Society for Research in Child Development*, *80*(4), 106–120.

Thompson, L. A., & Trevathan, W. R. (2008). Cortisol reactivity, maternal sensitivity, and learning in 3-month-old infants. *Infant Behavior & Development*, *31*(1), 92–106.

Thompson, R. A. (2008). Early attachment and later development: Familiar questions, new answers. In J. Cassidy & P. R. Shaver (Eds.), *Handbook of attachment: Theory, research, and clinical applications* (2nd ed., pp. 348–365). New York: The Guilford Press.

Tryphonopoulos, P. D., Letourneau, N., & Azar, R. (2014). Approaches to salivary cortisol collection and analysis in infants. *Biological Research for Nursing*, *16*(4), 398–408.

Vaughn, B. E., Lefever, G. B., Seifer, R., & Barglow, P. (1989). Attachment behavior, attachment security, and temperament during infancy. *Child Development*, *60*(3), 728–737.

Volling, B. L., & Belsky, J. (1992). Infant, father, and marital antecedents of infant-father attachment security in dual-earner and single-earner families. *International Journal of Behavioral Development*, *15*(1), 83–100.

Volling, B. L., Gonzalez, R., Oh, W., Song, J.-H., Yu, T., Rosenberg, L., … Safyer, P. (2017). Developmental trajectories of children's adjustment across the transition to siblinghood: Prebirth predictors and sibling outcomes at one year. *Monographs of the Society for Research in Child Development*, *82*(3), Serial No. 326.

Vondra, J. I., Shaw, D. S., & Kevenides, M. C. (1995). Predicting infant attachment classification from multiple, contemporaneous measures of maternal care. *Infant Behavior and Development*, *18*(4), 415–425.

Supplementary Table 1 follows.

Supplementary Table 1. Attachment ABCD categories by Attachment Configuration

Attachment Configuration	Attachment to Father				Attachment to Mother				Total *N*
	A	B	C	D	A	B	C	D	
Insecure Both	5	0	12	8	4	0	16	5	25
Secure Dad Only	0	32	0	0	5	0	22	5	32
Secure Mom Only	14	0	16	8	0	38	0	0	38
Both Secure	0	74	0	0	0	74	0	0	74