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The Importance of Shared Environment in Infant–Father Attachment: A Behavioral Genetic Study of the Attachment Q-Sort

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In this first behavior genetic study on infant–father attachment, we estimated genetic and environmental influences on infant–father attachment behaviors and on temperamental dependency, both assessed with the Attachment Q-Sort (AQS; B. E.Vaughn & E. Waters, 1990; E. Waters, 1995). Mothers of mono- and dizygotic twins (N = 56 pairs) sorted the AQS with a focus on the infant's behaviors in the presence of the father. Genetic modeling showed that attachment was largely explained by shared environmental (59%) and unique environmental (41%) factors. For dependency, genetic factors explained 66% of the variance, and unique environmental factors including measurement error explained 34%. Attachment to father appears to be, to a significant degree, a function of the environment that twins share.

keywords: attachment, fathers, behavioral genetics, shared environment, dependency

Is the caregiving environment as important to the development of infant–father attachment relationships as it is for infant–mother attachments? The Bowlby–Ainsworth attachment paradigm assumes that the infant's emotional bonds are not restricted to the biological mother but may also emerge in other relationships with protective adults such as fathers (Bowlby, 1969). Studies of infant–father attachment, however, show comparatively weak associations between paternal caregiving behavior and quality of the attachment relationship between infants and fathers (Braungart-Rieker, Garwood, Powers, & Wang, 2001; Rosen & Burke, 1999; Van IJzendoorn & De Wolff, 1997). Mental attachment representations of fathers correspond more strongly to the attachment quality with their children, but this correspondence is weaker than that for mothers and children (Van IJzendoorn, 1995). Child–father attachment itself appears less predictive for social–emotional outcomes than the quality of child–mother attachment (Aviezer, Sagi, Resnick, & Gini, 2002; Steele, Steele, Croft, & Fonagy, 1999).

Infant–father and infant–mother attachments were only weakly associated in the 14 studies (on 950 families in total) that Van IJzendoorn and De Wolff (1997) combined in their meta-analysis. The empirical evidence leaves room for an important role of genetically based child traits such as temperament instead of interactional history in shaping the quality of infant–father attachment. Indeed, Braungart-Rieker, Courtney, and Garwood (1999) found a significant effect of infant negative emotionality on infant–father attachment. In the current study, we used a behavioral genetic twin design to examine the relative weight of genetic, shared environmental, and unique environmental influences on the quality of infant attachment behavior toward the father.

Despite Harris's (1998) rejection of the importance of parenting for the development of their children in favor of the contributions of the child's genes and group socialization processes, attachment theory proposes that individual differences in security are explained by parental caregiving behavior rather than genetic causes (O'Connor & Croft, 2001; O'Connor, Croft, & Steele, 2000; Van IJzendoorn et al., 2000). Since Ainsworth's seminal work on attachment security and maternal childrearing behaviors in her Uganda and Baltimore samples (Ainsworth, 1967; Ainsworth, Blehar, Waters, & Wall, 1978), parental sensitivity has been considered one of the most important determinants of individual differences in attachment security (Main, 1999). Observational and experimental studies of attachment have generally confirmed this idea, although the mean effect size for the association between parental sensitivity and attachment security is relatively modest (in De Wolff & Van IJzendoorn's, 1997, meta-analysis, the combined effect was r = .24; see also Bakermans-Kranenburg, Van IJzendoorn, & Juffer, 2003).

To our knowledge, only four twin studies on child–mother attachment security using behavioral genetic modeling have been published thus far. Three of the four studies

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document a minor role for genetic influences on differences in attachment security, and a rather substantial role for shared environment (Bokhorst et al., 2003; O'Connor & Croft, 2001; Ricciuti, 1992). The fourth study, the Louisville Twin Study (Finkel & Matheny, 2000), investigated the quality of attachment in twin pairs with an adapted separation–reunion procedure originally designed for assessing temperament. They estimated that heritability of attachment is 25% and that the remaining variance may be attributable to nonshared environmental influences.

The large role of shared environmental factors in attachment is one of the most intriguing findings of attachment twin studies. Shared environment makes siblings within the same family more similar to each other and less similar to siblings in other families. Unique environmental factors make siblings within the same family more different from each other. In few other behavioral genetic studies is the shared component substantial; in general, the unique and/or genetic component is predominant (Bouchard & Loehlin, 2001).

In the current twin study, we focus on the infant–father attachment relationship as assessed with the Attachment Q-Sort (AQS). Waters and Deane (1985) introduced the AQS as an alternative to the Strange Situation laboratory procedure (Ainsworth et al., 1978) for assessing attachment security in infants and toddlers. The AQS consists of 90 specific behavioral descriptions of 12- to 48-month-old children in the natural home setting, with special emphasis on secure-base behavior (Vaughn & Waters, 1990). The AQS has some potential advantages over the Strange Situation procedure in the context of twin research. In particular, using the Strange Situation in twin studies implies separating the twins not only from their parent but also from the other twin. In some cases the validity of the Strange Situation may be reduced because the child may be more than mildly stressed by the separation from both parent and twin sibling. Furthermore, the AQS allows not only for the measurement of attachment security but also for various other constructs because only a subset of the behavioral descriptions are meant to index security. Waters and Deane (1985) included a contrasting construct, dependency, in order to test the relation between attachment security and temperamental dependency (Ainsworth, 1969).

The current twin study, therefore, concerns attachment security as well as temperamental dependency. Our hypothesis was that dependency is more heritable than attachment security. Temperament theory and research have documented the rather large role of genetic influences in the emergence and development of several temperamental traits, such as reactivity and inhibition (Bouchard, & Loehlin, 2001; Emde et al., 1992; Goldsmith, Lemery, Buss, & Campos, 1999; O'Connor & Croft, 2001). Dependency is indexed by behaviors such as excessive distress before and after separation at home with other caregivers and clinging, fussy, and demanding behaviors. Waters and Deane (1985) empirically documented the absence of an association between security and dependency at one year of age, although temperamental dependency may predict the type of attachment security or insecurity and may show a larger influence at a later stage in development (Vaughn & Bost, 1999). In the current study we tested whether security and dependency are the outcomes of different constellations of genetic, shared, and unique environmental factors. Because in the current study attachment and dependency are measured in the same context and with the same method, differences between models for attachment and dependency can be directly compared.

Method

Participants

Fifty-six twin pairs (21 monozygotic and 35 dizygotic same-sex pairs, 31 male and 25 female pairs) and both their parents participated in this study. The families were recruited through the Netherlands Twin Register (Boomsma, Orlebeke, & Van Baal, 1992). The original sample consisted of 77 families (see Bokhorst et al., 2003). Both parents were asked to describe the children's behaviors toward their father with the items of the Attachment Q-Sort. Fifty-six mothers and 49 fathers completed the AQS. We did not find any significant difference between the original and effective sample in terms of educational level, gender distribution, zygosity, age of parents, or their working hours out of home.

Most families were middle class. The mean age of the fathers was 35 years ($SD = 5.10$), and the mothers' mean age was 32 years ($SD = 3.69$). Only 1 father worked less than 4 days per week out of the home (mean hours of work was 41.2, $SD = 8.53$), and only 5 mothers worked 4 days or more out of the home ($M = 12.20$ hr, $SD = 11.97$).

Design and Procedure

Security of the father–child attachment relationship was assessed when the children were between 14 and 15.5 months of age. The experimenter asked the mother to sort the AQS after observing the interaction of each child with his or her father for several days. The fathers were also asked to sort the AQS regarding each child's (attachment) behaviors in their presence. Mothers and fathers completed the AQS independently, after a careful instruction in the sorting procedure, with help of a videotaped example of parents engaged in sorting. The parents were unaware of the study hypotheses.

Measures

The Attachment Q Sort (AQS). The parents were asked to describe each child's typical (attachment) behaviors in the presence of the father by sorting the 90 cards into 9 piles (with 10 cards each) from "most descriptive of the child" to "least descriptive of the child" (Waters & Deane, 1985). The security score was computed by correlating the parents' Q-description with the criterion sort for security based on experts' sorts of the AQS for an ideal securely attached child. The dependency score was computed by correlating the parents' Q-description with the criterion sort for dependency based on experts' sorts of the AQS for a prototypical dependently behaving child (potential range for both scores = -1.00 to $+1.00$).

Because both the mothers and the fathers sorted the Q-items for the relationship between the infants and their father, it was possible to compute the reliability of the sorting procedure. The mean reliability (alpha) of the mother and father sorts was .65. Mean differences between the mother and father scores for attachment and dependency were not significant. We decided to use the mothers' AQS as the index for the relationship of the infants with their father because self-reported AQS has proved to be less valid (Van IJzendoorn, Vereijken, Bakermans-Kranenburg, & Riksen-Walraven, 2004).

Zygosity determination. Zygosity was determined with Goldsmith's (1991) Zygosity Questionnaire for Young Twins. This questionnaire was completed three times by the mother: at 10 months of age, at 12 months of age, and at 3 years of age. Questions concerned similarities of physical features of the twins and experiences of mistaking one twin for another. To validate our decision about the twins' zygosity, we used Rietveld et al.'s (2000) discriminant equation. According to this equation, all but one pair were correctly diagnosed. This pair was re-diagnosed as dizygotic.

Statistical Analysis

In behavioral genetic analyses, the similarity of pairs of twins is divided into similarity due to additive genetic factors (A) and similarity due to shared environmental experiences (C), and dissimilarity is accounted for by unique or nonshared environmental influences and measurement error (E). The genetic analyses were performed with the program Mx (Neale, Boker, Xie, & Maes, 1999), which provides estimates of the parameters in the model (A, genetic factors; C, shared environment; E, nonshared environment and measurement error) and an overall chi-square goodness-of-fit index. A small chi-square corresponds to good fit, and a large chi-square corresponds to bad fit (and lower *p* values). For details, see Neale et al. (1999). The analyses presuppose equal parental treatment of mono- and dizygotic twins. On five questions concerning parental management of daily routines like feeding, sleeping, dressing, and providing play materials, no significant differences between mono- and dizygotic twins were found.

Results

In Table 1, the means, standard deviations, and correlations of AQS security and dependency scores in the total sample and in the subsamples of mono- and dizygotic twins are presented. AQS attachment security and dependency did not correlate significantly ($r = -.18$, 95% $CI = -.38$ to .08, $p = .19$, for Child 1, and $r = -.19$, 95% $CI = -.32$ to .05, $p = .15$, for Child 2), and the correlations between the residual scores (controlling for the attachment security and dependency scores of the co-twin) were not significant ($r = -.25$, $p = .07$, for Child 1, and $r = -.26$, $p = .06$, for Child 2). Moreover, the absolute difference scores of attachment security and dependency were not associated ($r = .13$, $p = .35$). Twins who were more different on dependency were not more different on attachment security.

Table 1
Means and Standard Deviations of AQS Attachment Security and Dependency in Monozygotic and Dizygotic Twins

Sample	AQS attachment security		AQS dependency	
	M	(*SD*)	*M*	(*SD*)
Total sample ($N = 56$)				
Child 1	.34	(.13)	−.19	(.15)
Child 2	.33	(.12)	−.16	(.18)
Correlation of Child 1 and Child 2	.63**		.32**	
Monozygotic ($n = 21$)				
Child 1	.37	(.12)	−.20	(.13)
Child 2	.36	(.12)	−.20	(.12)
Correlation of Child 1 and Child 2	.58**		.48*	
Dizygotic ($n = 35$)				
Child 1	.33	(.14)	.19	(.17)
Child 2	.31	(.12)	−.13	(.20)
Correlation of Child 1 and Child 2	.64**		.28	

Note. AQS = Attachment Q Sort. $N = 56$ pairs.
* $p < .05$. ** $p < .01$.

AQS security. For AQS security, the model with all three factors included (genetic, shared environmental, and unique environmental factors [ACE]) fit the data adequately, $\chi^2(3, N = 112) = 1.13$, $p = .77$, but the more parsimonious CE model was the preferred model, $\chi^2(4, N = 112) = 1.13$, $p = .89$, as the difference in chi-square was not significant and the CE model was simpler than the ACE model. Fifty-nine percent of the variance in attachment security was explained by shared environmental influences (C), and 41% of the variance by unique environment and measurement error (E). The AE model showed a significant reduction in fit in comparison with the ACE model and was thus rejected. Further restriction of the model with both A and C fixed to zero (the E model) reduced the fit significantly, $\chi^2(5, N = 112) = 23.80$, $p < .01$, Akaike's information criterion = 13.80, indicating the CE model as the plausible model. Using the fathers' self-reported Q-descriptions of their children showed similar results, again indicating the CE model as the plausible model.

AQS dependency. The important role of heritability in temperamental dependency was shown by the results of modeling the genetic, shared, and nonshared components with the Mx program. The AE model was the preferred model, $\chi^2(4, N = 112) = 8.03$, $p = .09$, and the model indicated that 66% of the variance in dependency was explained by genetic factors and 34% of the variance was attributed to unique environmental factors and measurement error. The ACE model, $\chi^2(3, N = 112) = 8.03$, $p = .04$, showed no influence of shared environment on dependency, and the CE model, $\chi^2(4, N = 112) = 11.32$, $p = .02$, did not fit the data as well as the AE model.

Discussion and Conclusions

This first behavioral genetic study on infant–father attachment security suggests that the individual differences in the security of the attachment relationship with fathers have to be explained by nongenetic, environmental factors. More importantly, infant–father attachment security appeared to be determined by shared environment to a substantial degree (59%). Unique environmental factors (including measurement errors and unique experiences of each child within the family) explained 41% of the variance in attachment security. In contrast, we found that temperamental dependency was largely (66%) genetically determined. As security and dependency were assessed in the same context and with the same Q-sort measure, the contrasting behavior-genetic models for both constructs cannot be explained by procedural differences.

The findings confirm expectations about the genetic origin of temperamental features derived from previous temperament theory and research (Kohnstamm, 1986; Vaughn & Bost, 1999). Indeed, behavior-genetic studies on temperamental dimensions such as reactivity or inhibition show clear-cut and considerable genetic influences (Emde et al., 1992; Robinson, Kagan, Reznick, & Corley, 1992). At the same time, the finding of a predominant environmental dimension in attachment security extends the results of some behavior-genetic studies on infant–mother attachment (Bokhorst et al., 2003; O'Connor & Croft, 2001; Ricciuti, 1992) to the domain of infant–father attachment. The current study, however, should be considered exploratory. The first limitation of this study is the size of the sample. Although the models for security and dependency are clear-cut, they need to be replicated in larger samples in order to obtain more precise estimates of the percentages of genetic, shared, and unique components. It is reassuring that the findings for both domains do not diverge strongly from related studies on larger (infant–mother) samples. The second limitation is the AQS restriction to the security versus insecurity dimension, which excludes further categorical distinctions on the level of insecurity. Lastly, the mother assessed infant–father attachment. We consider her AQS to be more comparable to the observer AQS than the father's self-reported AQS, with the advantage that the mothers have better access to infant–father interactions throughout the day than any observer is able to have (Waters & Deane, 1985). Nevertheless, the mother's internal working model of relationships and, for example, the marital quality may affect the "meaning" to the mother of the infant's attachment to the father, and these factors may bias the mother's sorting. There was rather large overlap between mother report and father self-report, however, and both sets of data yielded similar results. In future studies on the heritability of infant–father attachments, the additional use of the observer AQS should be recommended.

The meaning of shared environment with respect to attachment requires clarification. Paternal sensitivity could be part of this shared environment. By responding in varying ways to different children in their care, sensitive parents create a shared environment conducive for the emergence of secure attachments (O'Connor & Croft, 2001), even though concrete parental behaviors might be unique for each child. Furthermore, paternal sensitivity may manifest itself in other ways than maternal sensitivity (Lamb, 1997). For example, Grossmann et al. (2002) suggested that in traditional families fathers exercise their influence on the child's attachment development through emphasizing exploratory and rough-and-tumble play, whereas mothers may show their sensitivity in their openness to the emotional needs of their children. Other studies find that paternal caregiving and infant–father attachment depend more on marital discord than does maternal caregiving (Lundy, 2002; Owen & Cox, 1997). As fathers become attachment figures for their children through their social interactions—and not their genes—preventive interventions of insecurity should also focus on the fathers. The current findings certainly support the importance of new approaches toward explaining the surprisingly large impact of the shared environment on infant–father attachment and toward enhancing paternal sensitivity in the context of the family.

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