A BEHAVIOURAL GENETIC ANALYSIS OF ATTACHMENT STYLES IN ADULT TWINS

by

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Abstract

A total of 219 twin pairs (115 monozygotic, 75% female) aged 16 to 79 years completed the Relationship Scales Questionnaire (RSQ) and the Relationship Questionnaire (RQ). Data analyses estimated the heritability of Bartholomew's four adult attachment styles, the self- and other-model dimensions, and examined gender differences in genetic and environmental influences. The results showed an additive genetic and a non-shared environmental component for the secure, fearful, and preoccupied adult attachment styles whereas the dismissing style was characterized by shared and non-shared environmental components. No evidence of sex-specific genetic or shared environmental effects was found. These results shed some light on the controversy between temperament theorists who emphasize genetic influences and attachment theorists who emphasize environmental influences on attachment.

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A Behavioural Genetic Analysis of Attachment Styles in Adult Twins

Since the first writings in the early 1950s, attachment theory has stimulated a great deal of research. Much of this research has emphasized the primary role of environmental factors for the development of attachment. It is possible to test this assumption using behavioural genetic analyses but the heritable basis of attachment in adults has not been investigated to date.

Finkel, Wille, & Matheny (1996) conducted a pilot study of 30 infant twin pairs to examine the influence of heredity on attachment. Their preliminary results suggest that there may be some genetic influences on attachment, but the age and size of their sample limit the extent to which the results from their study can be generalized to adult attachment relationships.

Family studies of attachment conducted on parents and offspring are unable to separate genetic and environmental sources of variation in attachment. The lack of behaviour genetic research examining genetic influences on attachment styles has lead to a large gap in the literature. Having noted two previous major findings in attachment research[1], P. R. Shaver (personal communication, 26 October, 1995) wrote "(w)hen this controversy is eventually resolved through large, careful twin studies, the result will be the third major finding in recent years."

The current twin study was designed to reduce the gap in the attachment literature by estimating the heritable basis of attachment and exploring the role of gender differences in attachment styles.

Attachment Theory and Research

Bowlby's landmark writings on the development of personality through the making and breaking of affectional bonds spurred research in the area now known as attachment theory. Attachment theory is not intended to be a general theory of relationships, but a theory about those relationships most fundamental to our feelings of security. In childhood, these relationships generally include the parents, and in adulthood they encompass (although they are not limited to) romantic relationships.

Bowlby (1969) theorized that the propensity to attach is "hard-wired" and is a motivational drive as basic as those of eating and sleeping. In childhood, the attachment drive ensures that the child will maintain proximity to the caregiver, especially in times of danger, thereby increasing chances for survival. The attachment drive is activated by two different types of environmental stimuli. The first is danger or threat and the second relates to the accessibility and responsiveness of the attachment figure (Bowlby, 1969; Berman, Marcus & Berman, 1994). Once attachment is activated, the behavioural system severely constrains the types of behaviours an individual can manifest to those that will increase or maintain proximity to the attachment figure. As a result, in times of activation, the child will immediately seek proximity to and comfort from his or her primary caregiver (Bowlby, 1969).

Attachment theory postulates a developmental model in which each individual progresses along one of an array of potential pathways for personality development. The particular pathway is primarily determined by the environment encountered[1]. Of primary influence in a child's environment is the treatment she or he receives from parental

caregivers and how the child responds to them (Bowlby, 1988). As a result of caregivers' differential emotional availability and responsiveness, children develop different "internal working models (IWMs)," that is, mental representations of relational patterns with significant others (Bowlby, 1988). These internal working models are thought to determine the expression of the attachment system by establishing the individual's belief in the availability and consistency of the attachment figure (i.e., the child's model of other) and in his or her own worthiness as a recipient of security and comfort (i.e., the child's model of self; Bowlby, 1973). Subsequently, the IWMs are thought to be basic to the development of personality, and to determine the expression of the attachment system by guiding cognitive, emotional, and behavioural response patterns (Collins & Read, 1994). Individual differences in attachment styles result from differing models of self and other.

In order to study Bowlby's theory, Ainsworth developed the Strange Situation Procedure (SSP), in which children are observed with a caregiver, usually a parent, in a series of departure and reunion episodes claimed to reflect the quality of their relationship (Ainsworth, Bell, & Stayton, 1974). Using this procedure, Ainsworth identified three attachment styles in childhood: secure, avoidant, and ambivalent. Children with consistently responsive and sensitive caregivers who effectively respond to their needs will likely develop a secure style, viewing the self as worthy of being loved and cared for and others as being trustworthy and caring. Children with caregivers who consistently reject the child's comfort-seeking will develop a model of themselves as unworthy of care or as independent and not in need of care and a model of others as

untrustworthy or uncaring, resulting in the avoidant attachment style. Finally, when caregivers are inconsistent in their responses to the child's comfort-seeking, the child becomes uncertain about the availability of others and the worthiness of the self and, as a result, develops an ambivalent model.

Several researchers have extended the study of attachment into adulthood. Among them is Main (George, Kaplan, & Main, 1984), who developed the Adult Attachment Interview (AAI), and Hazan and Shaver (1987), who designed a self-report measure for adults with classifications parallel to Ainsworth's childhood attachment classifications. More recently, Bartholomew (1990; Bartholomew & Horowitz, 1991) reconceptualized the adult attachment classification system, and, in the process, added a fourth attachment style. In her reconceptualization, attachment styles exist on two continua, the first being the sense of self, and the second, the view of the other. Thus, a secure individual has a positive sense of self and a positive view of other (i.e., the self as worthy of care, and the other as trustworthy and caring); a preoccupied individual has a negative view of self and a positive view of other (i.e., the self as unworthy of care, and the other as untrustworthy or uncaring); a dismissing person has a positive view of self and a negative view of other (i.e., the self as independent and not in need of care, and the other as untrustworthy); and a fearful individual has a negative view of both self and of other (i.e., the self as unworthy of care and the other as uncaring). In essence, her model divides Ainsworth's avoidant category into fearful and dismissing. Although Bartholomew has developed both self-report and interview measures to assess these

styles, it is preferable to use interview methodology in order to reduce presentation bias and allow greater confidence in the results (Griffin & Bartholomew, 1994).

Despite children's propensities to develop organized and functional IWMs by one year of age, the models allow room for adjustment, either in order to accommodate new experiences or to develop new ways of thinking about past experiences (Steele & Steele, 1994). Nevertheless, these models are believed to be relatively stable, especially after the third year of life (Bowlby, 1988). Once they are formed, they tend to operate automatically and unconsciously, similar to a reflex. A securely attached child will gradually up-date the IWM as she or he is treated differently by caregivers, resulting in reasonably accurate simulations of the self and the caregiver in interaction. An anxiously attached child will experience difficulty up-dating his or her IWM because of a tendency defensively to exclude discrepant experience and information (Bowlby, 1988). As a result, IWMs are generally modified only through significant emotional experiences, radical change within the same early relationship across time, repeated experience in other relationships that disconfirms earlier acquired models, and/or especially strong emotional experiences within a single relationship that also disconfirm earlier models (Ricks, 1985).

Family Studies

Intergenerational transmission. Attachment styles are thought to be transmitted from one generation to the next (intergenerational transmission). "...(C)hildren tend unwittingly to identify with parents and therefore adopt, when they become parents, the same patterns of behaviour that they themselves have experienced during their own

childhood..." (Bowlby, 1969, p. 323). A meta-analysis conducted by van IJzendoorn (1995) combining the results of 18 family studies, including samples of mothers and/or fathers and their infants (N=854), found the correspondence between parental and infant attachment classifications to be 70%.

Most attachment theorists hypothesize that the strong patterns of intergenerational transmission result from the parents' IWM guiding their expression of attachment through their ability to respond sensitively to their children, thus influencing their children's developing models of self and other (Fonagy, Steele, Steele, Moran & Higgit, 1990). As a result, their children will differ in their levels of security, tending to mimic the parents' style (Steele & Steele, 1994, p.112-3).

The hypothesis emphasizing environmental influences on attachment may well turn out to be supported by empirical evidence, but the consistency between parent and offspring attachment styles could also result from genetic factors or from a combination of genetic and environmental factors. Support for possible genetic effects comes from van IJzendoorn's (1995) meta-analysis. Consistent with the environmental hypothesis put forth by Fonagy et al. (1990), his results showed a relation between parents' representation of attachment and their sensitive responsiveness. Nevertheless, parents' attachment security explained only about 12% of the variation in their responsiveness to their children. The largest part of the relationship between parents' attachment classifications and their children's attachment classification remained unexplained, leading to speculation regarding other mechanisms that may be operating to cause this

"transmission gap" (van IJzendoorn, 1995). He suggested that plausible mechanisms include genetic influences, temperament, and personality.

Temperament. The extent to which the child's temperament versus parental characteristics contribute to the development of attachment relationships has generated a great deal of controversy. Many temperament theorists claim that classifications derived from the SSP may reflect children's temperamental differences, in addition to, or even instead of, individual differences in attachment styles to the primary caregiver (Fox, Kimmerly, & Schafer, 1991; Goldsmith & Alansky, 1987; Kagan, 1982; Vaughn et al., 1992).

Attachment theory acknowledges that there is a complex interaction between infant and parental characteristics which affects the quality of the relationship and thus patterns of Strange Situation behaviour, but the most significant direction of influence is thought to occur from the parent to the child (Sroufe, 1985). This is partly due to the greater cognitive and socio-emotional competence which enable the caregiver to accommodate to the child's distinct temperamental style (Rosen & Rothbaum, 1993). Temperamental influence on attachment style is believed by many attachment theorists to be minimal because the SSP is thought to reflect the quality of the infant-caregiver relationship (Sroufe & Waters, 1977).

Family studies have provided evidence for and against the influence of temperament on attachment. For example, some researchers have found a lack of concordance between a child's attachment classification with his or her mother and the same child's classification with his or her father (e.g., Belsky, Garduque, & Hrncir,

1984; Grossman, Grossman, Huber, & Wartner, 1981; Main & Weston, 1981). Theoretically, if children's characteristics have a strong influence on their attachment style, then they should be attached in the same way to both parents. Indeed, other researchers (Fox, Kimmerly & Schafer, 1991; Lamb, 1978; Rosen & Rothbaum, 1993) have found significant concordance between maternal and paternal attachment classifications. How might these discrepant patterns of findings be explained? Rosen and Rothbaum (1993) noted one possibility, namely that studies finding lack of concordance between infant-mother and infant-father SSP classifications tended to have a longer time period between testing each parent with the child whereas the opposite was true for studies finding concordance. But this does not necessarily point to temperament, which is theorized to be relatively built-in and unchangeable. Instead, it may reflect some other characteristics of the child's behaviour that change with age, or other factors, including changes in parental responsiveness and possible mother-father caregiving differences.

There seems to be growing consensus amongst both attachment and temperament theorists that an interactive model must be explored to attempt to find an explanation of the inconsistent results. Family studies confound genetic and environmental effects, so their results do not provide sufficient exploration of the influence of genes and the environment on attachment. A twin study, rather than a family study, would enable the partitioning of genetic and environmental variance and, thus, provide a clearer understanding of the mechanisms that may influence attachment styles. Nevertheless, to date there has been no research on attachment in adult siblings or twins.

Gender Differences

Bowlby did not predict that there would be gender differences in attachment styles and researchers using Hazan & Shaver's (1987) three category model have not reported them, but some gender differences have been obtained with Main's AAI (e.g., Kobak & Sceery, 1988). In general, researchers using Bartholomew's four-category model have found that more men are rated higher on the dismissing style and more women are rated higher on the preoccupied style (e.g., Bartholomew & Horowitz, 1991; Kobak & Sceery, 1988; Scharfe & Bartholomew, 1994). These differences may, at least in part, reflect the gender-related expectations or stereotypes of coders, who cannot be blind to gender for Bartholomew's interviews because the coding is done from audiotapes. They may also, however, reflect the differential socialization of men and women, the distinct effects of genes and the environment on males and females, or both in interaction. For example, the preoccupied style might have a genetic influence unique to females. Or, there may be greater genetic variation in females than in males, resulting in higher ratings for the preoccupied style for females. Conversely, the same may be true of the dismissing style for males.

Additional evidence for the possibility of gender differences in attachment styles comes from the research examining friendships. Specifically, researchers have consistently found that women's friendships are more often "face-to-face," whereas men's are "side-by-side" (Wright, 1982). In other words, women's friendships are based primarily on emotional sharing and men's friendships on engaging in common activities (Barth & Kinder, 1988; Hays, 1988; Sherrod, 1989; Winstead, 1986). Reis, Senchak,

and Soloman (1985) write that these differences occur not as a result of men's inability to form intimate friendships with other men, but rather because such male-to-male intimacy is less socially acceptable than is female-to-female intimacy. These differences in relating may translate into attachment styles. Men's greater inhibition and lesser experience in forming close relationships may mean they develop different attachment styles than women who have more experience and greater ease in forming such attachments.

Twin studies not only allow an examination of genetic and environmental variance in attachment styles, but also permit the assessment of genetic and common environmental effects which may be unique to each sex. They can indicate whether similar genetic and environmental processes are acting upon males and females, and thus, whether they should be studied jointly or examined separately.

Twin Methodology

Behavioural genetics considers both genetic and environmental influences as potential sources of behavioural differences amongst individuals. It allows the estimation of the relative extent to which behavioural differences are due to heredity and environment. A phenotype is the observable characteristic or behaviour one is measuring, and broad-sense heritability (h^2_B) is the proportion of phenotypic variance (V_P) that is attributable to all sources of genotypic variance (V_G; $h^2_B = V_G/V_P$). The variance of a phenotype is the linear sum of the genotypic variance (i.e., all genetic effects) and an environmental variance (V_E) encompassing all non-genetic causes ($V_P = V_G + V_E$).

Potential genetic effects are partitioned into additive (V_A) and dominant (V_D) effects. Additive effects operate directly from parent to offspring and sum linearly in their effect on the phenotype. This is the extent to which parents and children genetically resemble one another. Dominant effects involve the interaction of dominant and recessive alleles at the same loci (see Plomin, DeFries, & McClearn, 1990, for further details). Narrow-sense heritability (h^2) is the proportion of phenotypic variance due solely to additive genetic variance ($h^2 = V_A/V_P$).

The environmental sources of variation are partitioned into shared or common environment (V_C) and nonshared or unique environment (V_E). Shared environment is any experience influencing both twins in the same way (e.g., socioeconomic status). Nonshared environment includes error (e.g., measurement, and random) and any environmental influence that is unique to each twin (e.g., how each experiences their parents' divorce). When all the genetic and environmental effects are partitioned, the phenotypic variance becomes $V_P = V_A + V_D + V_C + V_E$.

Logic of the Twin Method.

Monozygotic (MZ) twins share 100% of their additive and dominant genes, whereas dizygotic (DZ) twins share only 50% of their additive and 25% of their dominant genes on average. One can take advantage of this knowledge by examining the degree of similarity between MZ and DZ twins. A genetic basis is suggested when MZs are more similar than DZs, the greater resemblance being due to the two-fold greater genetic similarity, with all other things being equal. The equal environments assumption is that MZ twins are not treated more similarly than DZ twins. If the MZ twin

environment were more similar than that of DZ twins, MZs would show more similarity relative to DZs, which would lead to an upward bias of heritabilty. This equal environments assumption has been a concern, but there is support for it from observational studies (Lytton, 1977) and studies using self- and parent-report (e.g., Kendler, Neale, Kessler, Heath, & Eaves, 1993; Kendler, Neale, Kessler, Heath, & Eaves, 1994; Morris-Yates, Andrews, Howie, & Henderson, 1990; Rowe, 1983). In addition, Morris-Yates, Andrews, Howie, & Henderson (1990) examined the effect of violation of this assumption on the heritability and environmental estimates and found it to be negligable. It also has been found that DZ twins are treated more similarly than are regular siblings simply because they are twins (Jang, 1993). This greater similarity in treatment of DZ twins make them more like MZ twins in this regard, and thus reduce any upward bias in the heritability coefficient (Jang, 1993).

Current Study

Although Bowlby (1969) allowed for the interaction of genes and the environment in influencing the development of attachment behaviours[2], attachment researchers have traditionally emphasized environmental influences on attachment and discounted genetic factors. To date, challenges to this assumption have tended to originate from temperament researchers who claim that attachment classifications may instead reflect a child's temperament. An important step in resolving this controversy involves conducting a twin study to determine whether there may be genetic influences on attachment. This was the main focus of the adult twin study conducted for this thesis. In addition, gender differences in attachment styles were explored to ascertain whether

genetic and environmental influences were similar for females and males or whether different mechanisms may be exerting varying influence.

Hypotheses

1. Increasingly, both the evidence regarding intergenerational transmission of attachment styles and temperament research indicate that genes may influence attachment styles. The best-fitting model for each of the attachment styles and the self- and other-model was hypothesized to be an ACE model, indicating the combined influence of genes, shared, and nonshared environment on the development of a particular attachment style. In this model, the genetic influence was hypothesized to account for the evidence found in the two areas of study described above. The shared environmental influence was hypothesized to result from the parent's IWM of attachment which would lead to the same parenting style, in terms of sensitivity of caregiving, for both twins (thus influencing their attachment styles in similar ways). The non-shared environment was hypothesized to account for the increasingly different adult twin environments and for error. For example, most adult twin pairs are no longer living at home, or going to school together, but most importantly, they have different current primary attachment figures (e.g., spouses), and differing past histories with (non-parental) partners.

2. It was hypothesized that there would be gender differences in keeping with those found in studies employing Bartholomew's four-category model and that they would result, in part, from the differential influences of genes on attachment styles in males and females. For example, the higher preoccupied ratings sometimes found for females may

be the result of a greater proportion of genetic variance on the preoccupied style for females than for males, and /or unique female genetic effects.

Method

Participants

The participants were volunteer twin pairs recruited from the Lower Mainland through newspaper advertisements and media stories by the University of British Columbia Twin Project, an on-going behavioural genetic study of psychiatric disorder conducted by Drs. Jang and Livesley, in the Department of Psychiatry, Faculty of Medicine. A twin pair was eligible to participate if the twins were aged 16 years or over and were raised in the same home. A total of 115 MZ twin pairs (89 sister pairs and 26 brother pairs; mean age 31.3 years, S = 11.0, range = 17 - 79 years) and 104 DZ twin pairs (63 sister pairs, 16 brother pairs, 25 sister-brother pairs; mean age 31.3 years, S = 13.8, range = 16 - 66 years) participated. Zygosity was determined through a questionnaire (Kasriel & Eaves, 1976; Nichols & Bilbro, 1966) which has been shown to be 95% as accurate as red blood cell polymorphism analyses.

Measures

Each twin completed a battery of questionnaires at home, and pairs were instructed to complete the questionnaires independently in a non-distracting setting. The measures of attachment were the Relationship Questionnaire (RQ; Bartholomew & Horowitz, 1991), and the Relationship Scales Questionnaire (RSQ; Griffin & Bartholomew, 1994).

Relationship Questionnaire. The RQ (Appendix A) is an adaptation of the attachment measure developed by Hazan and Shaver (1987). It consists of four short paragraphs describing the four attachment patterns (secure, fearful, preoccupied, and dismissing). Participants are asked to pick the one paragraph that best describes them. They also rate the degree to which they resemble each of the four styles on a 7-point scale. The RQ attachment ratings show convergent validity with interview ratings (Bartholomew & Horowitz, 1991; Griffin & Bartholomew, 1994). The correlation coefficients between Bartholomew's interview ratings and the RQ ratings range from .22 to .50 (for the secure and fearful ratings, respectively). Moderate stability has been found over 8 months (Scharfe & Bartholomew, 1994), with 63% of the female participants and 56% of the male participants reporting the same attachment pattern.

The RQ can be used either to generate a continuous rating for each attachment pattern or a single attachment category, defined either as the one paragraph selected by the participant or as the pattern with the highest rating on the 7-point scales. It can also generate scores on the self- and other-model dimensions. Scores on the four attachment styles are entered into the following equation for the self-model: (Secure + Dismissing) - (Preoccupied + Fearful). The other-model score is generated by the following equation: (Secure + Preoccupied) - (Dismissing + Fearful).

Relationship Scales Questionnaire. The RSQ (Appendix B) is a 38-item self-report measure, but only 18 items are used to calculate the four attachment patterns. Additional items were included to make the RSQ comparable to other researchers' self-report measures of attachment (Griffin & Bartholomew, 1994). Items in the RSQ are

drawn from Hazan and Shaver's (1987) attachment measure, the RQ, and Collins and Read's (1990) Adult Attachment Scale. Measures of each of the four attachment patterns (secure, fearful, preoccupied, and dismissing) identified by Bartholomew and Horowitz (1991) were created by summing four or five items from the corresponding prototypic descriptions. Each participant receives a continuous rating for each attachment pattern. Scores on the self- and other-model dimensions can also be generated using the equations described above.

The internal consistencies of the RSQ adult attachment scores are variable and, in some cases, low, ranging in one sample from alpha = .41 for the secure style to alpha = .70 for the dismissing style (Griffin & Bartholomew, 1994). The RSQ pattern scores show convergent validity with interview ratings, with correlation coefficients ranging from .25 for the secure style to .47 for the dismissing style. This finding suggests that security of attachment may be particularly susceptible to self-report biases. Overall, the modest correlations indicate that the interview and self-report methods of measurement are far from identical.

K. Bartholomew (personal communication, August, 1995) believes that the RSQ provides a more reliable measure than the RQ. A multi-item attachment measure generally is more reliable than a single-item measure because the single-item measure is more sensitive to even small changes in response tendency (Griffin & Bartholomew, 1994)

Data Analyses

Data analyses involved several steps before heritability could be calculated. First, the normality of the data was examined because this is required by the maximum likelihood estimation procedure used in genetic model fitting.

The RSQ attachment styles were found to be normally distributed, so no changes were made in the distribution for the heritability analysis. The RSQ self- and other-model dimensions were also normally distributed. The sex-limitations analysis required that the data for the preoccupied adult attachment style be transformed into z-scores in order to obtain meaningful results. This was required because the greater complexity of the sex-limitations model being tested increased sensitivity to outliers.

The RQ attachment style data were not normal and could not be transformed to normality. It was, therefore, decided to use only the self- and other-model dimensions in the RQ heritability analysis instead of the data for the four attachment styles.

Pearson's correlation coefficients were calculated for each of the twin groups. The first set of correlation coefficients divided the sample into MZ and DZ twin pairs. Subsequent correlations were calculated for MZ and DZ sub-categories (i.e., female MZ, male MZ, female DZ, male DZ, opposite-sex DZ).

The next step in the analyses involved calculating the covariance matrices of each of the constructs of interest. For each construct, seven covariance matrices were calculated. Simple heritability analysis requires a matrix for the MZ twin pairs and another for the DZ twin pairs. Sex-limitations analysis requires a matrix for the MZ male, DZ male, MZ female, DZ female and DZ opposite-sex twin pairs.

To examine whether there were significant gender differences in ratings on each of the attachment styles, t-tests were calculated using a random sample of one twin from each pair.

Heritability analyses. The purpose of these analyses was to estimate the variance in each of the four adult attachment styles attributable to additive genetic factors (A), shared environmental factors (C), and nonshared environmental factors (E) by fitting a model to the data. Dominance genetic factors (D) were also estimated for the styles when there was evidence for such effects, as indicated by a ratio of the MZ correlation to the DZ correlation greater than two. The similarity (r) of reared-together twins is attributable to only three distinct parameters: additive and dominant genetic influences (for MZs: A + D effects; DZs: ½ A + ¼ D effects) and common environment (C). Note that nonshared environmental effects (E) are not estimated directly but are simply the residual variance after the effects of A, D, and C have been removed. Genetic model-fitting determines the best combination of A, D, C, and E accounting for the variation in a trait. Figure 1 depicts the traditional path model. The structural model used most frequently to estimate heritability is the A, C, E model because it evaluates the effects of additive genetic variance (A), and thus only narrow-sense heritability; common environmental variance (C); and nonshared environmental variance (E).

It should be noted that a model that fits well is not necessarily most appropriate or useful. According to the rule of parsimony, one attempts to fit a model that is able to predict a wide range of phenomena with the smallest set of parameters. For example, the structural model A, C, E mentioned above allows the fitting of three additional models

that systematically test the relative importance of each of the three components. To determine whether a purely environmental model (C, E) can account for the data, the additive genetic influence is removed. Likewise, an A, E model predicts no common environmental effects, and an E only model predicts no familial resemblance.

Goodness-of-fit of a model is determined by chi-square (x^2). A nonsignificant x^2 means that the model provides a good fit to the data. Aikaike's Information Criterion (AIC) is also applicable and is considered more appropriate in assessing fit in models with a small number of parameters. It is computed as: original x^2 - (2 x original df) and the model with the lowest value of this index is said to fit best, with a negative AIC value being lower than a low positive one.

Mx (Neale, 1991) is a statistical modelling program used for twin data analyses. It is one of several structural equation modelling programs and was designed to meet the demands of modelling genetically informative data. Models are built using matrix formulae that can be specified in any way the user likes, and the program provides facilities for boundary, linear, and non-linear constraints. Boundary and linear constraints maintain that all parameter estimates are sensible (i.e., are not greater than unity). Programs such as Lisrel do not allow for these constraints.

Analyses for the first hypothesis began by estimating the magnitude of genetic and environmental effects using the path model shown in Figure 1. This was translated into Mx script as outlined in Appendix D (for details see Neale & Cardon, 1992, pp. 100-102). In order to test whether subsequent (simpler) models provided a better fit to the data, the x^2 and the Akaike Information Criterion (AIC) were used. Models were fit

separately for data gathered from the RQ and the RSQ to determine whether different results were obtained.

Sex-limitations analyses. Two approaches to the second hypothesis were used. Most of the participants in this study, as is the case in most twin studies (Lykken, Tellegen, & DeRubeis, 1978), were female. This raised the concern that gender differences might not be evident, or clear, in the sex-limitation modelling analysis. Some readers may also question the appropriateness of combining the genders in testing the first hypothesis when there were so few males. To address this issue, the models tested in Hypothesis 1 were re-run on the female and the male participants separately.

A test of heterogeneity between the sexes examined whether there were significant differences in the proportions of genetic and environmental influence on each of the adult attachment styles. This test was conducted by fitting a model to the male and female data together (i.e., in the same Mx program script) but defining these groups separately. The sum of the two x^2 statistics obtained from the best-fitting models for the males and females separately was then subtracted from the x^2 value obtained from fitting these two groups together. A non-significant x^2 value implies that the genetic and environmental variance components are not significantly different for males versus females.

Behavioural genetics methodology allows one to estimate the magnitude of genetic, shared, and nonshared environmental effects on male and female phenotypes and determine whether the same set of genes or shared environmental experiences influences a trait in males and females. This form of analysis is referred to as sex-limitation model-

fitting and is diagramatically depicted in Figure 2. Specifically, it allows the examination of whether gender differences found in studies employing the four-category model result from discrepancies in the effects of genes or environmental experiences on males and females.

The second approach to the analysis of the second hypothesis involved sex-limitation modeling. To estimate the magnitude of genetic and environmental effects on males and females and to determine whether the same genes or shared environmental experiences influence the adult attachment styles of males and females, the path diagram shown in Figure 2 was translated into Mx script (for details see Neale & Cardon, 1992, pp. 212-217) and run using the RSQ data.

Results

Heritability

Table 1 reports the means and standard deviations for each of the constructs assessed by the RQ and the RSQ. The self- and other-model dimensions have standard deviations which are larger than the means. This reflects the fact that the scores on these constructs ranged from negative to positive values. For example, scores on the RQ self- and other-models ranged from -11 to 12 and scores on the RSQ self- and other-models ranged from -5.90 to 5.65. In a normal distribution with such a range, the mean will tend to be near zero and the standard deviation should have a larger absolute value.

The initial step in the heritability analysis involves examining the Pearson's correlation coefficients between co-twins for each of the styles and model dimensions. They are reported in Table 2. The secure, fearful, and preoccupied styles present higher

MZ than DZ correlations, indicating possible genetic influence on these styles. The dismissing style has a similar MZ and DZ correlation, suggesting that genes may not be important determinants of this style and that the environment may play a more important role in familial resemblance on this dimension.

Subsequent behavioural genetic model-fitting confirmed the trends apparent in the correlations[3]. The results from the analyses of the four adult attachment styles are summarized in Table 3. Heredity and non-shared environmental influence play an important role in the secure, fearful, and preoccupied styles. Common environmental and non-shared environmental influence is more important for the dismissing style. Model-fitting indicates that the AE model is most appropriate for the secure, fearful, and preoccupied styles and that the CE model fits best for the dismissing style. Table 4 reports the goodness-of-fit statistics for all the models that were fit to the data. Lower x^2 and AIC values (including negative numbers) indicate a better fit.

The pattern of correlations between the MZ and DZ twin pairs for the RQ self-model indicate that there are no genetic influences, since the DZ twin correlation is *larger* than the MZ twin correlation. The other-model seems to have a strong genetic component, as the MZ correlation is much larger than the DZ correlation. Heritability analysis confirmed that the best fitting model for the self-model dimension is the CE model (see Tables 3 and 5). The AE model provides the best fit for the other-model, thereby indicating a non-significant shared environmental influence. Table 5 reports the goodness-of-fit statistics for all the models that were fit to the data.

The RSQ data give results for the self- and other-model dimensions that are opposite to the RQ results. The RSQ correlation coefficients reported in Table 2 indicate a possible genetic influence for both the self- and the other-models, although it may be too weak to be significant for the other-model. Behaviour genetic model-fitting found that the AE model provides the best fit for the self-model dimension. The CE model best fits the other-model dimension. Parameter estimates are presented in Table 3. Goodness-of-fit statistics are reported in Table 5.

Gender Differences

Gender differences in mean RSQ ratings on each of the four adult attachment styles were tested using t-tests on a random sample of one twin from each pair. Contrary to previous results for studies employing Bartholomew's four-category model, there were no significant differences. The results of the t-tests are presented in Table 6.

The correlation coefficients reported in Table 2 for the attachment styles of female twin pairs mirror the patterns found in the previous section. The secure, fearful, and preoccupied styles show a larger MZ than DZ twin correlation, whereas the dismissing style has a larger DZ twin correlation. Genetic model-fitting confirmed these results. The AE model provides the best fit for the secure, fearful, and preoccupied adult attachment styles, whereas the CE model best fits the dismissing style. Parameter estimates are presented in Table 7. Goodness-of-fit statistics are reported in Table 8.

For the male twin pairs, there appears to be some genetic influence for the secure and fearful styles, since the MZ correlations are considerably larger than the DZ correlations. The preoccupied style has a similar correlation coefficient for both the MZ

and DZ twins, and the dismissing style has a slightly larger MZ correlation coefficient, indicating possible, but likely non-significant genetic influence. Model-fitting confirmed these patterns. An AE model provides the best fit for the secure and fearful adult male attachment styles, whereas a CE model provides the best fit for the preoccupied and dismissing styles. Parameter estimates are presented in Table 7. Goodness-of-fit statistics are reported in Table 8.

The test for heterogeneity between the sexes was non-significant for all the styles. Due to the difference in best-fitting models for males and females on the preoccupied style, the ACE model x^2 statistics were compared. The results are presented in Table 9.

Sex-limitation analyses found that the best model fitting the secure, fearful, and preoccupied patterns is the AE model, with no unique male or female additive genetic, shared environmental effects (see Tables 10 and 11). The CE model with no unique male or female genetic or shared environmental effects provides the best fit for the dismissing data.

Discussion

Heritability

The first hypothesis predicted genetic influence on the attachment styles and the self- and other-models. Specifically, it was hypothesized that an ACE model would provide the best fit, indicating additive genetic, shared environmental, and non-shared environmental influence. This hypothesis was partially supported for the RSQ adult attachment style data. Genetic influence was found for the secure, fearful, and preoccupied adult attachment styles. Surprisingly, shared environmental influence was

found to be non-significant. This finding seems to contradict attachment theory, which specifies that parental treatment determines a child's attachment style. This may reflect the age of the sample. Most (69%) of the twins no longer live in the same home and may have started their own families (42% are married). As a result, they may have different primary attachment figures. In childhood, they would have shared the parents as primary figures, but in adulthood, they increasingly turn to romantic partners. This difference may have been heightened by the focus of both questionnaires on close relationships rather than specifically on parent-child relationships.

Another surprising result was the lack of genetic influence found for the dismissing style. The best-fitting model for the combined sample, as well as for female and male twins when analyzed separately, was the CE model. Recall that Ainsworth theorized three attachment styles in childhood, and that for adulthood, Bartholomew divided the avoidant style into the fearful and the dismissing styles. Perhaps there is a key difference between the avoidants who become fearful and those who become dismissing. One possibility is that the genetic influence on the fearful style is mediated through a personality trait such as Neuroticism[4]. Evidence to support this possibility comes from a study by Griffin and Bartholomew (1994), who compared the five basic personality scales (Neuroticism, Extraversion, Openness to Experience, Agreeableness, and Conscientiousness), as assessed by the short form of the NEO Personality Inventory (Costa & McCrae, 1985), with the self- and other-model[5]. They found that the self-model dimension (as measured by both the RQ and RSQ) was moderately negatively correlated with Neuroticism (-.49 for the RQ and -.55 for the RSQ). This indicates that

as one's self model becomes more negative, which is the case with the preoccupied and fearful styles, one's Neuroticism score increases. Thus, individuals high on the preoccupied and/or fearful attachment styles tend to have high Neuroticism scores, whereas those high on the secure and/or dismissing attachment styles tend to have low Neuroticism scores.

The relationship to Neuroticism provides a plausible explanation for the genetic influence on the fearful and preoccupied styles, but it also raises another question: why does the secure style show evidence of genetic influence but the dismissing style does not? An answer to this question may lie in the moderate positive correlation between Extraversion and the other-model found by Griffin and Bartholomew (1994; .30 for the RQ and .39 for the RSQ). As the other-model scores become more positive the Extraversion score increases. Secure and preoccupied individuals have high other-models, so it makes sense that they would tend to have high Extraversion scores, whereas the low other-models of the fearful and dismissing styles would lead them to have low Extraversion scores.

The results of the heritability analysis conducted on the RQ and RSQ self- and other-model variables were in stark contrast. The CE model provided the best fit for the RQ self-model whereas the AE model provided the best fit for the other-model. The RSQ data gave the opposite results, indicating an AE model for the self-model dimension and a CE model for the other-model. The RQ data probably should be interpreted with caution. K. Bartholomew (personal communication, August, 1995) has expressed her

reservations about the validity of the RQ and has suggested that the RSQ provides a more reliable measure.

The results from the RSQ data partially supported the first hypothesis. On the one hand, the self-model was found to have genetic influence, but on the other hand, the shared environmental influence was not significant. The other-model showed significant shared environmental influence but not genetic influence. As with the attachment styles, it is possible that personality is the avenue of genetic influence on the self-model. This speculation is consistent with Griffin and Bartholomew's (1994) finding that the NEO personality scales explained 48% of the variance in the self-model, but considerably less (27%) of the other-model variance.

Gender Differences

The second hypothesis predicted that there would be gender differences in keeping with those found in other studies using Bartholomew's four category model. Remarkably, results of t-tests showed that there were no gender differences in the mean ratings of each of the attachment styles. The discrepancy may relate to the different samples. A community-based older sample was used for this study, whereas studies in which gender differences were found were based on younger university student samples (e.g., Bartholomew & Horowitz, 1991; Kobak & Sceery, 1988; Bartholomew & Scharfe, 1994).

Heritability analyses conducted separately on males and females showed consistent results for the secure, fearful, and dismissing attachment styles. The preoccupied style had an AE model for the female data and a CE model for the male

data. These contrary findings may have resulted from the much smaller male sample size or may reflect gender differences that would have emerged in the sex-limitations analyses had the male sample size been larger.

The test of heterogeneity between the sexes in the causes of variation of each of the attachment styles was non-significant. This implies that the genetic and environmental components do not exert significantly different influence on males and females. For example, males are not significantly more influenced by genes or significantly less influenced by non-shared environment on the secure style than are females. In other words, the magnitude of genetic and environmental influence was not significantly different for males and females.

The second hypothesis also predicted that gender differences would result, in part, from differential influences of genes on the attachment styles in males and females. Sex-limitation analysis revealed that none of the styles was influenced by unique male or female genes or shared environment. This finding implies that the *same* set of genes and shared environmental experiences influence attachment styles in males and females. This is consistent with the lack of gender differences in mean ratings of attachment styles and with the findings from the test of heterogeneity between the sexes.

It remains possible that the small male sample size prevented significant gender differences from being discovered, but these findings are, nevertheless provocative. Three broad conclusions are implied. First, there were no gender differences in the mean ratings of self-reported adult attachment styles in a community sample. Second, the magnitude of genetic and environmental effects did not differ for males and females.

Third, the same set of genes and shared environmental experiences was found to influence attachment styles in males and females. The same factors seem to be influencing females and males to the same degree and in the same way. The lack of gender differences may also imply that socialization and non-shared environment do not cause differences in attachment styles in males and females, but it is impossible to be certain because one would require opposite-sex MZ twin pairs to test this hypothesis.

Limitations of the Study

There were several limitations of the study which must be considered when interpreting the results. These include the quality of the measures used, the small male sample size, and the age of the sample.

Ideally, an interview measure such as Bartholomew's Peer or Family Adult Attachment Interviews or Main and Goldwyn's Adult Attachment Interview (AAI) would be used, and multiple expert coders would rate each individual's attachment style. The interview protocols show greater validity (van IJzendoorn, 1995) and stability (Scharfe & Bartholomew, 1994) than do self-report measures. Nevertheless, given the lack of any research on twins, the results found using the self-report measures provide a solid and fascinating starting point from which to interpret genetic and environmental influences on attachment styles.

Most of the participants in this study, as is the case in most twin studies (Lykken, Tellegen, & DeRubeis, 1978), were female. The large female sample allows confidence in the female results and these findings can be considered fairly robust, but the small number of male twin pairs may have inhibited significant gender differences from being

discovered. Future replications of this study should attempt to recruit a greater number of male participants before greater confidence can be placed in these results.

Another consideration is the age of the sample. It is possible that genes and the environment exert differing degrees of influence at different stages in the life cycle. Different results might be obtained with a younger sample still living with their parents and primarily attached to them. In particular, shared environment may play a more significant role earlier in development.

Conclusions

This exploratory study has provided some preliminary but suggestive results. The assumption made by attachment theorists that parental responsiveness is of primary importance in determining an individual's attachment style was not supported by this study for three of the four adult attachment styles. This suggests that attachment theory may have to consider genetic influences on attachment styles rather than limiting its focus to environmental factors. Bowlby believed the propensity to attach to be "hard-wired" and mentioned the possibility of genetic influence on attachment behaviour[2]. Perhaps more attention should have been given to this source of variation rather than focusing research almost exclusively on environmental influences.

It is still unclear whether any genetic influence on attachment styles and the self- and other-models results from the relationship between temperament or personality and attachment. Future studies should examine this relationship more carefully in order to determine whether the genetic variance can be entirely accounted for by these constructs

in addition to or instead of attachment. In other words, is there a genetic influence on attachment after the effects of temperament or personality are partialled out?

The debate on genetic versus environmental influences on attachment will continue until these issues can be resolved in a more satisfactory manner. The provocative findings of this study take the debate a step closer to resolution at the same time as they raise further questions and avenues for exploration.

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Appendix A

Relationship Questionnaire (RQ) Items

Secure pattern: It is easy for me to become emotionally close to others. I am comfortable depending on them and having them depend on me. I don't worry about being alone or having others not accept me.

Fearful pattern: I am uncomfortable getting close to others. I want emotionally close relationships, but I find it difficult to trust others completely, or to depend on them. I worry that I will be hurt if I allow myself to become too close to others.

Preoccupied pattern: I want to be completely emotionally intimate with others, but often find that others are reluctant to get as close as I would like. I am uncomfortable being without close relationships, but I sometimes worry that others don't value me as much as I value them.

Dismissing pattern: I am comfortable without close emotional relationships. It is very important to me to feel independent and self-sufficient, and I prefer not to depend on others or have others depend on me.

Note. Each paragraph is rated on a 7-point scale ranging from 'Not at all like me' to 'Very much like me.' The measure was worded in terms of general orientations to close relationships.

Appendix B

Relationship Scales Questionnaire (RSQ) Items

1. I find it difficult to depend on other people. (Fear)
2. It is very important to me to feel independent. (Dis)
3. I find it easy to get emotionally close to others. (Sec)
4. I want to merge completely with another person.
5. I worry that I will be hurt if I allow myself to become to close to others. (Fear)
6. I like to be with people.
7. I am comfortable without close emotional relationships. (Dis, Pre-R)
8. I am not sure that I can always depend on others to be there when I need them.
9. I want to be completely emotionally intimate with others. (Pre)
10. I worry about being alone. (Sec-R)
11. I am comfortable depending on other people. (Sec)
12. I welcome the opportunity to mix socially with people.
13. I often worry that romantic partners don't really love me.
14. I find it difficult to trust others completely. (Fear)
15. I worry about others getting too close to me.
16. I want emotionally close relationships.
17. I am comfortable having other people depend on me. (Sec)
18. I prefer working with others rather than alone.
19. I worry that others don't value me as much as I value them. (Pre)
20. I find that people are never there when you need them.

21 My desire to merge completely sometimes scares people away.

22. It is very important to me to feel self-sufficient. (Dis)

23. I am nervous when anyone gets too close to me.

24. I find people more stimulating than anything else.

25. I often worry that romantic partners won't want to stay with me.

26. I prefer not to have other people depend on me. (Dis)

27. I worry about being abandoned.

28. I am somewhat uncomfortable being close to others. (Fear)

29. I find that others are reluctant to get as close as I would like. (Pre)

30. I'd be unhappy if I were prevented from making many social contacts.

31. I prefer not to depend on others. (Dis)

32. I know that others will be there when I need them.

33. I worry about having others not accept me. (Sec-R)

34. Romantic partners often want me to be closer than I feel comfortable being.

35. In relationships, I often wonder whether my partner really cares about me.

36. I want to get close to people but I worry about being hurt by them.

37. I find it relatively easy to get close to others.

38. When I show my feelings for others, I'm afraid they will not feel the same about me.

Note. Items scored on a 5-point scale ranging from 'Not at all like me' to 'Very like me'. Items that make up subscales for the attachment patterns defined by the four-

category model are marked as follows: Sec = Secure, Fear = Fearful, Pre = Preoccupied, and Dis = Dismissing. R indicates reversed scoring.

Appendix C

Sample Mx Script for the Univariate ACE Model

```
! Model for dismissing attachment style (RSQ data) on MZ and DZ twin pairs
! Univariate example testing ACE model
! sec = secure; fear = fearful; pre = preoccupied; dis = dismissing
# define nvar 1
Title Group 1: parameters of model
Calculation Ngroups=3
Matrices
X Full nvar nvar Free        ! additive genetic parameter
Y Full nvar nvar Free        ! share environment parameter
Z Full nvar nvar Free        ! unique environment parameter
W Full nvar nvar             ! dominant genetic parameter
H Full 1 1                   ! scalar, .5
Q Full 1 1                   ! scalar, .25
End Matrices;
Matrix H .5
Matrix Q .25
Begin Algebra;
A = X * X';                  ! a²
C = Y * Y':                  ! c²
E = Z * Z';                  ! e²
```

```
D = W * W';          ! d²
V = A + C + E + D;   ! total variance
P = A | C | E | D;   ! put parameter estimates in one matrix
                     ! the | operator concatenates matrices with same number of
                     ! rows
S = P@V~;
End Algebra;
Labels Row X parest_a
Labels Row Y parest_c
Labels Row Z parest_e
Labels Row W parest_d
Labels Row A a^2
Labels Row C c^2
Labels Row E e^2
Labels Row D d^2
Labels Row V variance
Labels Row P estimate
Labels Col P a c e d
Labels Row S standest
Labels Col S a^2 c^2 e^2 d^2
End
Title G2: DZ pairs
```

```
Data NInput_vars = 8  NObs = 63

CMatrix Lower .52 .1588 .52

Labels sect1 feart1 pret1 dist1 sect2 feart2 pret2 dist2

Matrices = Group 1

Covariances A + C + E + D | H@A + C + Q@D _

            H@A + C + Q@D | A + C + E + D/

Option RSiduals

Option NDecimals = 4

End

Title G3: MZ pairs

Data NInput_vars = 8  NObs = 90

CMatrix Lower .58 .1607 .54

Labels sect1 feart1 pret1 dist1 sect2 feart2 pret2 dist2

Matrices = Group 1

Covariances A + C + E + D | A + C + D _

            A + C + D | A + C + E + D/

Option RSiduals

End
```

Footnotes

[1]The first major recent development in attachment research, according to Shaver, was Main's demonstration that parents' AAI classification predicts, with approximately 80% accuracy, how the child will be classified in the SSP. The second finding would be if the longitudinal studies show continuity in attachment style from childhood into adulthood.

[2]Bowlby did not entirely discount genetic influence on attachment. In his 1969 book, he wrote "(i)n the development of attachment behaviour, as in the development of every biological character, nature and nurture play continually interacting parts (p. 296)." However, the environment was seen as exerting the primary influence on attachment behaviours and subsequent attachment theorists have tended to ignore genetic influences in their research.

[3] DZ opposite-sex twins were not included in the simple heritability analysis.

[4] In personality studies, approximately 50% of the variation in personality reflects genetic effects (see review by Bouchard, 1994).

[5] In order to test whether personality truly accounts for the genetic variance in attachment the genetic correlation between all the personality traits and the attachment styles must be computed.

Table 1

Means, and Standard Deviations for Adult Attachment Styles and Self- and Other-Models Assessed by the RSQ and RQ

RSQ	M	SD
Secure	3.45	.67
Fearful	2.45	.91
Preoccupied	2.63	.76
Dismissing	3.30	.73
Self	1.68	1.82
Other	.33	1.99
RQ		
Self	2.80	4.42
Other	.72	4.38

Table 2

Pearson's Correlation Coefficients for Adult Attachment Styles and Self-and Other-Model Dimensions assessed by the RSQ and RQ

RSQ	r_{MZ}	r_{DZ}	$r_{MZ\text{-}M}$	$r_{DZ\text{-}M}$	$r_{MZ\text{-}F}$	$r_{DZ\text{-}F}$	$r_{DZ\text{-}OS}$
Secure	.34***	.22*	.49*	.16	.29**	.20	.28
Fearful	.43***	.25*	.37	.09	.45***	.25*	.30
Preoccupied	.35***	.03	.17	.14	.41***	.01	-.18
Dismissing	.29**	.31**	.28	.17	.29**	.35**	.31
Self	.46***	.28*					
Other	.36***	.23*					
RQ							
Self	.37***	.46***					
Other	.24*	.02					

Note. ***p < .001, two-tailed; **p < .01, two-tailed; *p < .05, two-tailed.

Table 3

Estimates of Genetic and Environmental Influences on Adult Attachment Styles and the Self- and Other-Models Assessed by the RSQ and RQ

RSQ	h^2	c^2	e^2
Secure	.36	-	.64
Fearful	.42	-	.58
Preoccupied	.31	-	.69
Dismissing	-	.30	.70
Self	.47	-	.53
Other	-	.32	.68
RQ			
Self	-	.40	.60
Other	.21	-	.79

Note. h^2 = heritability estimate; c^2 = estimate of shared environmental influence; e^2 = estimate of non-shared environmental influence.

Table 4

Goodness-of-Fit Statistics for the RSQ Adult Attachment Styles

RSQ	Best-Fitting Model	x^2	df	AIC
Secure	ACE	2.41	3	-3.59
	AE	2.66	4	-5.34
	CE	3.42	4	-4.58
	E	21.69	5	11.69
Fearful	ACE	4.42	3	-1.59
	AE	4.63	4	-3.37
	CE	5.90	4	-2.10
	E	32.48	5	22.48
Preoccupied	ACE	3.12	3	-2.88
	AE	3.12	4	-4.88
	CE	6.20	4	-1.80
	E	17.22	5	7.22
Dismissing	ACE	1.18	3	-4.82
	AE	3.63	4	-4.37
	CE	1.18	4	-6.82
	E	18.90	5	8.90

Table 5

Goodness-of-Fit Statistics for the Self- and Other-Models assessed by the RSQ and RQ

RSQ	Best-Fitting Model	x^2	df	AIC
Self	ACE	4.58	3	-1.43
	AE	4.71	4	-3.29
	CE	7.14	4	- .86
	E	37.08	5	27.08
Other	ACE	2.35	3	-3.65
	AE	2.95	4	-5.06
	CE	2.66	4	-5.34
	E	22.90	5	12.90
RQ				
Self	ACE	2.75	3	-3.25
	AE	8.79	4	.79
	CE	2.75	4	-5.25
	E	36.65	5	26.65
Other	ACE	1.78	3	-4.22
	AE	1.78	4	-6.22
	CE	3.53	4	-4.47
	E	7.61	5	-2.39

Table 6

Gender Differences in Mean Ratings of RSQ Adult Attachment Styles and Self- and Other-Model Dimensions, as Assessed by t-tests

Style	Mean Rating		t	df
	Males	Females		
Secure	3.54	3.37	1.58	216
Fearful	2.44	2.51	- .52	215
Preoccupied	2.58	2.63	- .40	214
Dismissing	3.31	3.30	.07	216

Note. All t-tests are non-significant.

Table 7

Estimates of Genetic and Environmental Influences on RSQ Adult Attachment Styles for Female and Male Twin Pairs Separately

	h^2	c^2	e^2
Female			
Secure	.31	-	.69
Fearful	.44	-	.56
Preoccupied	.37	-	.63
Dismissing	-	.32	.68
Male			
Secure	.46	-	.53
Fearful	.33	-	.67
Preoccupied	-	.16	.84
Dismissing	-	.25	.75

Note. h^2 = heritability estimate; c^2 = estimate of shared environmental influence; e^2 = estimate of non-shared environmental influence.

Table 8

Goodness-of-Fit Statistics for Females' and Males' Adult Attachment Styles Separately

	Best-Fitting Model	x^2	df	AIC
Female				
Secure	AE	1.97	4	-6.03
Fearful	AE	2.69	4	-5.31
Preoccupied	AE	2.39	4	-5.61
Dismissing	CE	.40	4	-7.60
Male				
Secure	AE	3.47	4	-4.53
Fearful	AE	4.35	4	-3.65
Preoccupied	CE	7.25	4	- .75
Dismissing	CE	11.04	4	3.04

Table 9

Test of Heterogeneity Between the Sexes in the Causes of Variation of RSQ Adult Attachment Styles

Style	Model	x^2	df
Secure	AE	1.20	2
Fearful	AE	1.00	2
Preoccupied	ACE	4.05	3
Dismissing	AE	.57	2

Note. All x^2 values are non-significant.

Table 10
Parameter Estimates and Goodness-of-Fit Statistics Testing for Unique Male Effects on RSQ Adult Attachment Styles

Parameter	Secure	Fearful	Preoccupied	Dismissing
Common				
a_f	.13	.36	.16	0
c_f	0	0	0	.17
e_f	.27	.44	.80	.36
a_m	.23	.31	.42	0
c_m	0	0	0	.17
e_m	.24	.58	.67	.44
Unique				
a_m	0	0	0	0
c_m	0	0	0	0
Goodness-of-fit				
x^2	6.50	7.80	8.99	13.32
df	11	11	11	11
AIC	-15.50	-14.20	-13.01	- 8.68

Note. All x^2 are non-significant.

Table 11

Parameter Estimates and Goodness-of-Fit Statistics Testing for Unique Female Effects on RSQ Adult Attachment Styles

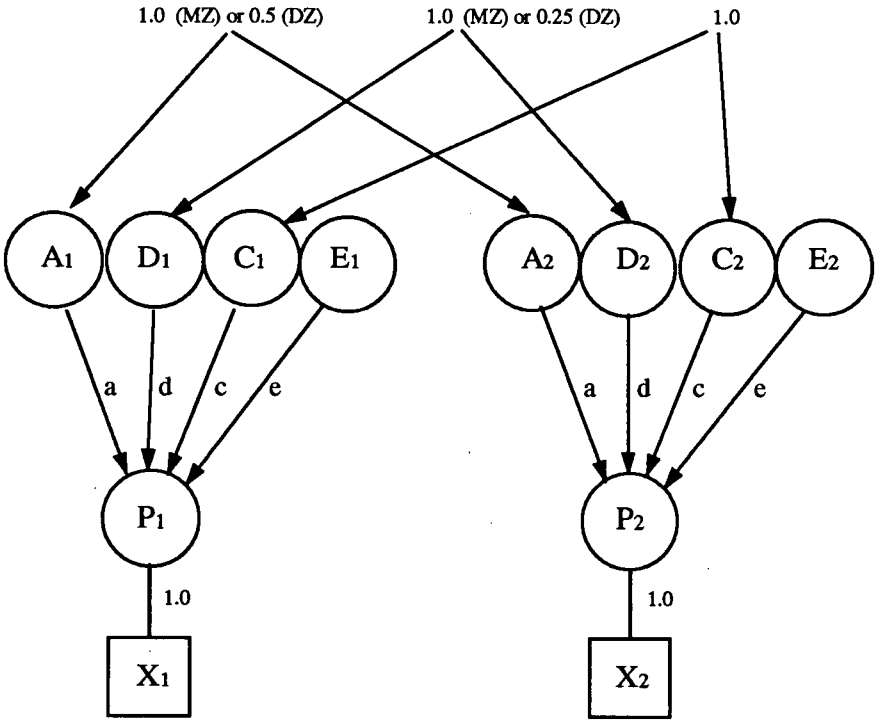
Parameter	Secure	Fearful	Preoccupied	Dismissing
Common				
a_m	.22	.30	.47	0
c_m	0	0	0	.14
e_m	.24	.57	.70	.42
a_f	.13	.36	.15	0
c_f	0	0	0	.18
e_f	.27	.44	.79	.37
Unique				
a_f	0	0	0	0
c_f	0	0	0	0
Goodness-of-fit				
x^2	6.67	7.91	7.84	13.97
df	11	11	11	11
AIC	-15.34	-14.09	-14.17	- 8.03

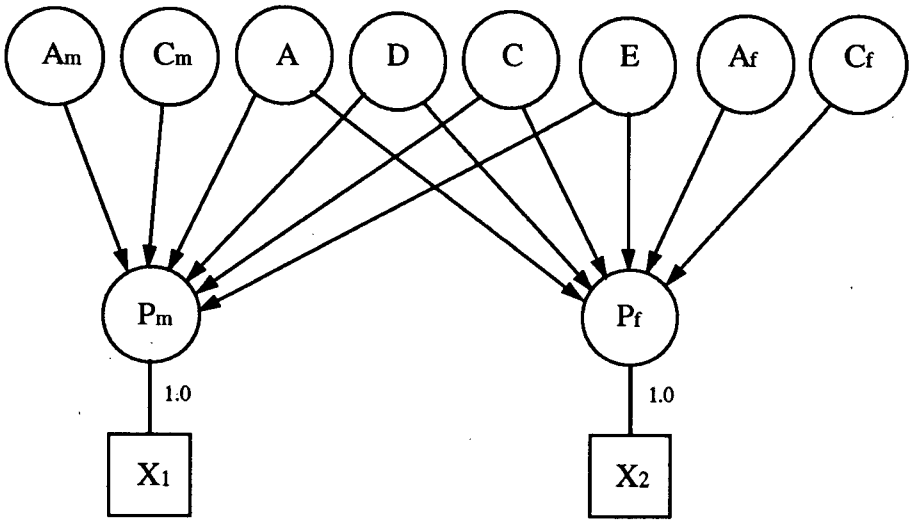
Note. All x^2 are non-significant

Figure Caption

Figure 1. Univariate model for data from MZ or DZ twins reared together. Genetic and environmental latent variables cause the phenotypes P1 and P2, which, in turn, cause the observed variables X1 and X2. See Neale & Cardon (1992) pp. 100-102 for further information.

Figure 2. The general genotype x sex interaction model for twin data. Path diagram is shown for DZ opposite-sex twin pairs. See Neale & Cardon (1992) pp. 212-217 for further information.


1.0 (MZ) or 0.5 (DZ)
1.0 (MZ) or 0.25 (DZ)
1.0
A1
D1
C1
E1
A2
D2
C2
E2
a
d
c
e
a
d
c
e
P1
P2
1.0
1.0
X1
X2


Am
Cm
A
D
C
E
Af
Cf
Pm
Pf
1.0
1.0
X1
X2