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Parenting and risk for mood, anxiety and substance use disorders: a study in population-based male twins

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Abstract

Background—Previous studies consistently identified a relationship between parenting behavior and psychopathology. In this study, we extended prior analyses performed in female twins to a large sample of twins from male–male pairs.

Methods—We used interview data on 2,609 adult male twins from a population-based twin registry. We examined the association between three retrospectively reported parenting dimensions (coldness, protectiveness, and authoritarianism) and lifetime history of seven common psychiatric and substance use disorders. Using univariate structural equation modeling, we also examined the influence of the genetic and environmental factors on parenting.

Results—Examined individually, coldness was consistently associated with risk for a broad range of adult psychopathology. Averaged odds of psychiatric disorders associated with parenting were increased between 26 and 36 %. When the three parenting dimensions were examined together, coldness remained significant for major depression, phobia, and generalized anxiety disorder. Controlling for other disorders, the associations between the parenting dimensions and psychopathology were non-specific. Twin fitting model demonstrated that modest heritability accounted for parenting, whereas most variance resulted from the non-shared environment.

Conclusions—Based on our current and prior findings, there is broad similarity in the impact of parenting on adult psychopathology between men and women.

Keywords

Parenting; Mental disorders; Population-based; Twins

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Introduction

The quality of parenting received as a child has a critically important influence on the child's mental health later in life. It has been common to consider parental behaviors as environmental influences. However, studies of twins and siblings have demonstrated that genetic as well as environmental factors contribute to parenting [1-4]. Several studies proposed three specific dimensions of parental behavior, including coldness, protectiveness, and authoritarianism [5-7]. In their review of genetic influences on the environment, Kendler and Baker [8] reported that the weighted heritability from child's reports was highest for measures of coldness (35 %), intermediate for measures of protectiveness (20 %) and lowest for measures of authoritarianism (15 %). They also reported that estimates of heritability obtained from parents' reports were similar in magnitude to those from child's reports.

A number of studies have consistently found associations between parenting style and risk for adult psychopathology including major depression (MD) [9-16], anxiety disorders [17-19] and externalizing behavior [20]. In our prior report, we investigated the association between parenting and eight common psychiatric and substance use disorders in female twins from a population-based sample [12]. We reported that parenting, especially levels of coldness, is associated with risk for most psychiatric disorders. Enns et al. [21] examined the association between parenting and 13 common mental disorders in a US national sample. They also reported that coldness was related in a non-specific manner to a wide variety of forms of adult psychopathology in both men and women. Heider et al. [22] examined the association between parenting and risk for anxiety disorders using large European samples and found a similar pattern of parenting behavior across anxiety disorders, with coldness and protectiveness having the strongest associations. Morgan et al. [23] examined the effects of parent-child relationships on later mental health status using two large UK birth cohorts. They found that poor relationships were associated with increased child mental health problems later in life (odds were increased between 20 and 80 %).

The aims of the present study were to clarify the relationship between parenting and psychiatric and substance use disorders in men and to estimate the relative importance of genetic and environmental influences on retrospectively reported parenting in male twins. To achieve these aims, we tried to answer the following four questions using a large, population-based twin sample: (1) What are the individual effects of maternal and paternal parenting behavior on risk for common psychiatric and substance use disorders? (2) Are there unique associations of particular parenting dimensions with specific forms of psychopathology when other parenting dimensions or disorders are examined jointly? (3) Can we find any role for interactions between parenting dimensions within a parent or between parents for each dimension in the prediction of psychiatric disorders in offspring? (4) What are the relative contributions of genetic and environmental factors to parenting in men? By answering these questions, we attempted to examine whether these factors in male twins were similar to or different from those observed previously in female twins [12].

Methods

Sample

We used twin data from the population-based Virginia Twin Registry—formed by a systematic review of all Virginia birth certificates since 1918. Twins were eligible if one or both members of a pair were successfully located, from multiple births, including at least one Caucasian male and born between 1940 and 1974. Of 9,417 eligible individuals for the first wave, interviews were completed, typically by telephone, with 6,814 (72.4 %). At least

1 year later, we recontacted the twins to schedule a second-wave interview. This interview was completed, mostly face-to-face, with 5,629 (82.6 %) of eligible. The assessment of parenting mentioned below was conducted only at the second-wave interview. The present study was based on the second-wave interview of 2,609 adult twins from male–male pairs (701 monozygotic (MZ) twin pairs, 485 dizygotic (DZ) twin pairs, and 237 single twins). At the time of the interview, the subjects had a mean age of 36.8 ± 9.1 years. The two members of each twin pair were interviewed by different interviewers who were clinically trained. Each interview was reviewed twice for completeness and consistency. This project was approved by our local Institutional Review Board and was carried out in accordance with the Declaration of Helsinki. Signed informed or verbal consent was, respectively, obtained prior to all face-to-face and telephone interviews.

Measure of parenting

The 25-item Parental Bonding Instrument (PBI) assesses parental rearing attitudes, based on the memory of subjects regarding their parents in their first 16 years [24, 25]. In the present study, parenting was measured by the modified 16-item PBI as described previously [5]. Similar to what we found previously in the female–female twin pairs [5], factor analysis of the modified PBI consistently extracted three factors: coldness, protectiveness, and authoritarianism. This has been replicated in samples in the US [6, 26], Japan [27], Brazil [28], and China [16]. The modified PBI included seven items indexing coldness, five for protectiveness and four for authoritarianism. High scores on the coldness scale reflect a parental style with low levels of warmth (e.g., ‘Seemed emotionally cold to you’ and ‘Did not talk to you very much’). High scores on the protectiveness scale reflect an overprotective and controlling parental style (e.g., ‘Tried to control everything you did’ and ‘Tended to baby you’). High scores on the authoritarianism scale index a parental style that discourages autonomy and independence [ex., ‘Liked you to make your own decisions’ (negative loading) and ‘Gave you as much freedom as you wanted’ (negative loading)].

Definitions of psychiatric and substance use disorders

The diagnoses considered in this study included MD, phobia, generalized anxiety disorder (GAD), panic disorder, alcohol dependence, and drug abuse and dependence. These disorders were diagnosed by personal interview using an adaptation of the Structured Clinical Interview for DSM-IV Disorders (SCID) [29] and DSM-IV criteria [30] with three exceptions (phobia, panic disorder, and GAD). Phobia was diagnosed using an adaptation of DSM-III-R criteria [31], which required the presence of 1 or more of 22 fears that the respondent recognized as unreasonable and that, in the judgment of the interviewer, objectively interfered with the respondent’s life. To maximize our power for the disorders with relatively low prevalence in our sample, we examined broader definitions of panic disorder and GAD using modified DSM-III-R diagnostic criteria. For panic disorder, a history of panic attacks that met at least two symptomatic criteria was required. GAD was diagnosed when the minimum duration of illness was 1 month rather than 6 months. We have shown that these approaches reflect the same continuum of liability as the fully syndromal disorders [32, 33].

Statistical analyses

Parenting style as a predictor of adult psychopathology—The report of parenting from single informants reflects both true parenting and reporting bias. We assumed that combined report of different informants should reflect more accurate parenting. Thus, we averaged reports on parenting given to each individual from both the twin himself and his co-twin as informants. Scores for each of the three parenting scales were standardized to *Z*-transformed scores with a mean of zero and variance of one.

We examined the relationship between the three parenting dimensions and the risk for lifetime psychiatric and substance use disorders using the logistic regression model. To correct for the non-independence of data from a twin pair, the generalized estimating equation (GEE) implemented in PROC GENMOD (SAS Institute Inc., Cary, NC, USA) was used. We included the subject's age at interview as a covariate in the model. The odds ratio (OR) was obtained by exponentializing the logistic regression coefficient. To correct for the total number of 42 tests conducted (three parenting in both mothers and fathers for each of seven diagnoses), a Bonferroni's corrected $P = 0.0012$ ($0.05/42$) was considered as a conservative test of significance.

We also tested for two types of interactions: between parents for the same parenting dimension (coldness, protectiveness, and authoritarianism in mothers \times fathers) and between parenting dimensions within a parent (coldness \times protectiveness, coldness \times authoritarianism, and protectiveness \times authoritarianism in mothers or fathers). We examined all two-way interactions using the logistic model. P values are reported two-tailed. As the analyses involved the total number of 63 interactions tested (nine interactions for each of seven disorders), a Bonferroni's corrected $P = 0.0008$ ($0.05/63$) was considered as a conservative test of significance.

Genetic and environmental influences on parenting—We examined the source of individual differences in dimensions of parenting in men using the twin design. Besides analyzing the combined reports, we separately conducted the analyses on reports by twins themselves and their co-twins as informants. Univariate structural equation modeling was conducted using the program Mx [34]. Mx allows for the variance of each parenting dimension to be decomposed into that due to additive genetic (A), shared environmental (C), and non-shared environmental (E) factors. In the standard ACE twin model, it is assumed that MZ twins share 100 % of their genes and DZ twins share, on average, 50 % of their segregating genes. Correlations of reared-together MZ and DZ twin pairs can be compared to estimate genetic, shared environmental and non-shared environmental factors, assuming equal environments for both types of twins. First, the full ACE model was fit to the data for each scale, including all three sources of variance. Then, the full model was modified and a series of reduced models were tested. The AE model tested the hypothesis of no effects of shared environment, the CE model tested no additive genetic effects and the E model tested no effects of either shared environment or genetic factors. The fit of these models was evaluated using the Akaike Information Criterion (AIC) [35]. A more negative AIC value indicates better fit.

Results

Parenting dimensions examined separately

Table 1 presents the ORs for the association between each parenting dimension and seven psychiatric and substance use disorders analyzed separately in mothers and fathers. All of the three parenting dimensions in both mothers and fathers were nominally significantly associated with all disorders, with ORs ranging from 1.13 to 1.76. Using a conservative threshold of $P = 0.0012$, coldness was consistently associated with adult psychopathology, although significant ORs were observed between protectiveness and authoritarianism and only some disorders. We compared the 21 ORs in mothers and fathers, with no significant difference observed at the level of $P < 0.05$. Averaged across disorders and parents, a one standard deviation increase in coldness, protectiveness, and authoritarianism measures was associated with an increase in risk for a disorder of 36, 26, and 27 %, respectively.

Specific relationship between parenting and psychopathology

The three parenting dimensions were significantly inter-correlated (all significant at $P < 0.0001$), except for paternal coldness–protectiveness ($P = 0.15$). Therefore, we examined the association of each dimension with seven disorders controlling for the other two dimensions (Table 2). The overall magnitude and significance of the associations declined for all three parenting dimensions. All associations of coldness and protectiveness dimensions with disorders remained significant except that of maternal protectiveness with panic disorder. Using a conservative threshold of $P = 0.0012$, ORs of coldness and protectiveness remained significant for some disorders (coldness for MD, phobia, and GAD, and protectiveness for phobia in both mothers and fathers). However, none of the associations of authoritarianism remained significant when other parenting dimensions were analyzed jointly.

We next examined the unique association of each parenting dimension with each disorder controlling for other disorders (Table 3). The overall magnitude and significance of the associations declined for all three parenting dimensions across all disorders. MD and phobia remained significantly associated with several parenting dimensions in both parents. However, only 4 of 42 ORs tested showed significance at the conservative level of significance ($P < 0.0012$). Overall, we could not find any particular parenting style contributing to specific form of psychopathology.

Interactions between parents and parenting dimensions

We further examined all two-way interactions between parents for each parenting dimension and between parenting dimensions within a parent. Of these, only significant results are shown in Table 4. Of the 21 possible interactions between parents for each parenting dimensions, one was positively significant: interaction between maternal and paternal coldness predicted a higher risk of drug abuse than that predicted from the main effects alone. Of the 42 possible interactions between the parenting dimensions examined separately within mothers and fathers, one was positively significant: interaction between protectiveness and authoritarianism in mothers in the prediction of MD. That is, in the presence of high protectiveness and authoritarianism, the risk for the disorder is higher than would have been predicted by the main effects. However, none of these significant interactions survive the conservative threshold ($P = 0.0008$).

Genetic and environmental influences on parenting

We investigated the role of genetic and environmental factors influencing the three parenting dimensions reported by the twins themselves and their co-twins separately and then combined (Table 5). For all dimensions, the observed MZ correlation was higher than the corresponding DZ correlation. Twin fitting model showed that the ACE, AE, and CE models fit significantly better than the E model for all parenting dimensions, indicating that there are sources of variance shared by twins. Therefore, the E model is not presented here. In some cases, the AE or CE model gave a slight improvement in fit over the ACE model, although no significant difference was observed in AIC values. Therefore, as suggested by Sullivan and Eaves [36], the parameter estimates and associated 95 % confidence intervals (CIs) from the full ACE model are presented here (Table 5). Overall, the ranges of 95 % CIs for each factor from self reports were very similar to those from the cotwin's reports.

For coldness, the estimates of heritability were higher in mothers (around 30 %) than in fathers (around 20 %). Conversely, the estimates of the variance due to shared environmental factors were higher in fathers than in mothers (30 % in fathers vs. 10 % in mothers). Non-shared environmental factors accounted for 50–70 % of the variance. For protectiveness and authoritarianism, the estimates of the variance due to genetic and shared

environmental factors were moderate (less than 40 %), whereas more than half of the variance was explained by non-shared environmental factors (60–80 %).

Discussion

We examined the association between risk for seven common psychiatric and substance use disorders and three parenting dimensions reported retrospectively by adult male twins. We also estimated the degree to which genetic and environmental factors contribute to parenting in men. We will review our findings in turn.

First, we assessed the independent association between individual disorders and each parenting dimension separately in mothers and fathers. ORs of offspring psychopathology ranged between 13 and 76 %, which is consistent with the previous studies in female twins [12] and UK large cohorts [23]. Especially coldness in both mothers and fathers was associated with risk for a broad range of offspring psychopathology, which is consistent with the previous studies reporting the association between parenting and depression [12, 16, 21] and substance use disorders [37, 38]. Of note, only a few prior studies have evaluated the association between parenting and anxiety disorders [12, 21, 22]. In accordance with those studies, our findings showed that the pattern of associations between parenting and anxiety disorders were similar to those between parenting and other disorders, including depression and substance use disorders, with coldness having the most significant association. Therefore, the present study strengthens the argument that parenting also plays an etiologic role in offspring anxiety disorders, just as it does with other disorders [22]. Parental psychopathology may also be associated with parenting behaviors (such as harsh punishment of child, poor communication and less time spent with child) that are likely to be perceived as lacking warmth. However, some studies have demonstrated that these maladaptive parenting behaviors themselves have higher impact on child psychopathology than parental psychopathology [39, 40].

Second, we examined whether there were any unique associations between particular parenting behavior and specific forms of psychopathology when other parenting dimensions or disorders were considered together. Because the three parenting dimensions were inter-correlated, we examined the specific impact of each dimension controlling for the other two. The effects of coldness and protectiveness were modestly reduced, whereas that of authoritarianism was completely diminished. These results suggest that the associations between authoritarianism and risk for psychiatric disorders are mediated through its positive correlations with coldness and protectiveness. Next, we investigated the unique association of each parenting dimension with psychopathology controlling for other disorders. In general, the associations between the parenting dimensions and psychopathology were non-specific, which is consistent with some previous studies [12, 21]. On the other hand, this result is inconsistent with others that reported specific relationships between parental coldness and control (including protectiveness and authoritarianism) and child depression and anxiety, respectively [17-19, 41]. The concurrent measures of parenting by child participants in those studies might reflect more accurate experience than by only retrospective reports [42]. In the present study, however, we collected data by face-to-face interview and combined reports on individual parenting from self and his co-twin, which reduces possible bias from a single perspective.

Third, we evaluated potential interactions between parents for each parenting dimension and between parenting dimensions within a parent in the prediction of risk for psychopathology. We found a positive interaction between maternal and paternal coldness in the prediction of drug abuse, suggesting that the combined effects of having two parents who are low on warmth/affection might increase a child's risk of drug abuse. This result is in line with the

previous studies showing that drug use was explained by an affectionless parental relationship [37, 38]. We also found positive interactions between protectiveness and authoritarianism in mothers in the prediction of MD, which is consistent with a result observed in female twins [12]. However, none of these significant interactions survive the conservative threshold, and so could have occurred by chance.

Fourth, we investigated the role of genetic and environmental factors influencing parenting reported retrospectively by men. The heritability of maternal coldness (30 %) was higher than that of paternal coldness (20 %). This is in line with findings reported in female twins, which showed consistent genetic contribution to parental warmth with a higher heritability in mothers than in fathers [5, 43]. The estimates of heritability were broadly similar in magnitude to those reported in previous studies [8]. The variance of genetic and shared environmental factors was <40 % for each parenting dimensions, whereas that of non-shared environmental factors ranged around 60 %. This pattern is consistent with the previous reports which showed strong non-shared environmental and modest genetic and shared environmental contributions to parenting [2, 3, 44]. These results, in which more than half of the variance for parenting was explained by non-shared environmental factors, suggest the importance of individual differences in child behavioral development [45]. However, it should be noted that the proportion of non-shared environmental variance estimated from this model is likely inflated due to measurement error.

Limitations

The results in the present study should be interpreted in the context of several limitations. First, this study included only Caucasian male twins. Generally, the results of the association between parenting and adult psychopathology in the present study were similar to those observed in female twins [5, 12]. However, it cannot be assumed that parenting variables are associated with risk for psychiatric disorders in the same way in families with non-twin offspring or in other races and cultures. Second, we largely relied on retrospective reports of parenting, which may produce recall bias due to many years since childhood. Correlations between observed child-rearing behaviors and later parenting recall are modest [46, 47], and reports of retrospective parenting are generally stable over time [48]. The perception of parenting may be influenced by other factors such as characteristics and mood state of the subjects. However, when MD discordant twin pairs were analyzed separately by MZ and DZ, affected twins' parenting reports from themselves and their healthy co-twins were significantly correlated (each parenting scale: $P < 0.05$). Therefore, it is not likely that parenting reports substantially are influenced by depressive state. Third, we investigated parenting reports from only offspring. Prior studies have reported that parents appear to emphasize the similarity with which they treated their children, whereas children are likely to emphasize the differences in treatment that they received [2]. Therefore, it is warranted to use multiple informants including parents in order to acquire a balanced picture of the nature of parenting. Fourth, the PBI covers only a limited range of parental behavior, which does not assess all parental behaviors that might influence the risk for psychiatric disorders in offspring. However, it is also possible that parenting has indirect effects on risk for adult psychopathology. For example, inadequate parental care may increase other risks such as sexual abuse [49, 50]. Fifth, parenting style may be associated with parental psychopathology as well as offspring psychopathology, both of which are in part determined by genetic factors. However, when we controlled for parental psychopathology in our prior study of female twins, the associations between parenting and offspring psychopathology were only modestly diminished [12]. Finally, the PBI assesses parenting behavior averaged over the first 16 years of child's life, which could not capture changes in the levels of parenting styles through the developmental stages of childhood and adolescence.

Conclusions

Despite these limitations, our study has methodological strengths, including a large population-based twin sample, interview data by both twins themselves and their co-twins, and the assessment of disorders using structured interview. Our findings demonstrated that parenting behaviors, especially coldness, were causally related to risk for a wide range of adult psychopathology. The results also showed that parenting was influenced moderately by genetic factors and was explained largely by non-shared environmental factors. Thus, the present findings suggest broad similarity in the impact of parenting on adult psychopathology between men and women.

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Table 1
Odds ratio for the association between parenting and seven psychiatric disorders

Diagnosis	Prevalence (%)	Mother			Father		
		Coldness	Protectiveness	Authoritarianism	Coldness	Protectiveness	Authoritarianism
Major depression (26.2)	1.29 ^{*****}	1.31 ^{*****}	1.27 ^{*****}	1.44 ^{*****}	1.19 ^{*****}	1.33 ^{*****}	
Phobia (21.9)	1.22 ^{*****}	1.31 ^{*****}	1.13 [*]	1.23 ^{*****}	1.22 ^{***}	1.14 [*]	
GAD (18.2)	1.33 ^{*****}	1.31 ^{*****}	1.27 ^{*****}	1.36 ^{*****}	1.20 ^{**}	1.27 ^{*****}	
Panic disorder (2.2)	1.76 ^{*****}	1.39 [*]	1.74 ^{***}	1.60 ^{***}	1.41 ^{**}	1.45 [*]	
Alcohol dependence (24.0)	1.15 ^{****}	1.23 ^{*****}	1.15 ^{**}	1.23 ^{*****}	1.17 ^{**}	1.20 ^{**}	
Drug abuse (21.6)	1.21 ^{*****}	1.14 ^{**}	1.14 ^{**}	1.34 ^{*****}	1.13 [*]	1.21 ^{***}	
Drug dependence (7.6)	1.31 ^{***}	1.31 ^{***}	1.20 [*]	1.54 ^{*****}	1.35 ^{*****}	1.28 ^{**}	

n = 2,609, Model contains parenting scale and twin age at interview

GAD generalized anxiety disorder

Significance levels:

* *P*<0.05

** *P*<0.01

*** *P*<0.001

**** *P*<0.0001

***** *P*<0.00001

Table 2

Odds ratio for the association between parenting and seven psychiatric disorders controlling for the other parenting dimensions

Diagnosis	Mother		Father	
	Coldness	Protectiveness	Authoritarianism	Authoritarianism
Major depression	1.23 ^{***}	1.26 ^{****}	1.11	1.17 ^{**}
Phobia	1.22 ^{***}	1.30 ^{****}	0.97	1.23 ^{****}
GAD	1.28 ^{****}	1.27 ^{****}	1.09	1.18 ^{**}
Panic disorder	1.59 ^{***}	1.27	1.31	1.40 [*]
Alcohol dependence	1.10 [*]	1.21 ^{***}	1.06	1.18 ^{**}
Drug abuse	1.19 ^{**}	1.12 [*]	1.03	1.31 ^{****}
Drug dependence	1.29 ^{**}	1.30 ^{**}	1.00	1.58 ^{****}

$n = 2,609$, Model contains three parenting scales (coldness, protectiveness, and authoritarianism) and twin age at interview

Correlations: Mother: coldness–protectiveness $\rho 0.08$ ^{****}, coldness–authoritarianism $\rho 0.39$ ^{****}, protectiveness–authoritarianism $\rho 0.27$ ^{****}

Father: coldness–protectiveness $\rho 0.03$, coldness–authoritarianism $\rho 0.47$ ^{****}, protectiveness–authoritarianism $\rho 0.23$ ^{****}

GAD generalized anxiety disorder

Significance levels:

* $P < 0.05$

** $P < 0.01$

*** $P < 0.001$

**** $P < 0.0001$

Table 3
Odds ratio for the association between parenting and seven psychiatric disorders controlling for other diagnoses

Diagnosis	Mother			Father		
	Coldness	Protectiveness	Authoritarianism	Coldness	Protectiveness	Authoritarianism
Major depression	1.15**	1.17**	1.17**	1.29****	1.08	1.23***
Phobia	1.12*	1.23****	1.05	1.12*	1.17**	1.06
GAD	1.16**	1.15*	1.13	1.13	1.07	1.10
Panic disorder	1.51***	1.15	1.50**	1.32*	1.27	1.24
Alcohol dependence	1.03	1.14*	1.07	1.06	1.09	1.10
Drug abuse	1.14*	0.99	1.09	1.19**	1.00	1.13
Drug dependence	1.11	1.21	1.04	1.26*	1.30*	1.09

n = 2,609, Model contains parenting scale, twin age at interview, and other diagnoses

GAD generalized anxiety disorder

Significance levels:

* *P*<0.05

** *P*<0.01

*** *P*<0.001

**** *P*<0.0001

Table 4

Significant two-way interactions between parents or parenting dimensions in the prediction of psychiatric and substance use disorders

Interaction	Dimension(s)	Disorder	Regression coefficient
Between parents	C	Drug abuse	F + 0.26 ^{****} M × F + 0.10 [*]
	P	Alcohol dependence	F + 0.14 M × F - 0.17 ^{**}
	A	Alcohol dependence	F + 0.17 [*] M × F - 0.12 [*]
	A	Drug abuse	F + 0.18 [*] M × F - 0.11 [*]
Between dimensions			
Mother	C × P	Drug abuse	P + 0.12 [*] C × P - 0.14 ^{**}
	C × P	Drug dependence	P + 0.29 ^{****} C × P - 0.20 ^{**}
	P × A	Major depression	A + 0.17 ^{**} P × A + 0.12 [*]
Father	P × A	Drug abuse	A + 0.18 ^{**} P × A - 0.13 [*]

M mother, F father, C coldness, P protectiveness, A authoritarianism

Significance levels:

* $P < 0.05$

** $P < 0.01$

*** $P < 0.001$

**** $P < 0.0001$

Table 5

Role of genetic and environmental influences on the three parenting dimensions

	<i>n</i>	Correlation		Variance (95 % CI)		<i>e</i> ²
		MZ	DZ	<i>a</i> ²	<i>e</i> ²	
Coldness						
Mother						
Twin as informant	2,429	0.37	0.24	0.30 (0.09–0.45)	0.09 (0.00–0.26)	0.62 (0.55–0.69)
Co-twin as informant	2,451	0.37	0.21	0.35 (0.14–0.44)	0.03 (0.00–0.21)	0.62 (0.56–0.69)
Average ^a	2,395	0.39	0.27	0.27 (0.06–0.46)	0.13 (0.00–0.31)	0.60 (0.54–0.67)
Father						
Twin as informant	2,372	0.46	0.38	0.18 (0.00–0.38)	0.29 (0.14–0.45)	0.53 (0.60–0.75)
Co-twin as informant	2,351	0.46	0.34	0.25 (0.05–0.46)	0.22 (0.03–0.39)	0.53 (0.47–0.60)
Average ^a	2,333	0.49	0.41	0.18 (0.00–0.38)	0.32 (0.14–0.47)	0.50 (0.44–0.56)
Protectiveness						
Mother						
Twin as informant	2,430	0.34	0.27	0.07 (0.00–0.30)	0.26 (0.06–0.37)	0.67 (0.61–0.73)
Co-twin as informant	2,396	0.33	0.17	0.30 (0.06–0.39)	0.03 (0.00–0.23)	0.68 (0.61–0.75)
Average ^a	2,383	0.37	0.26	0.14 (0.00–0.37)	0.22 (0.01–0.38)	0.64 (0.58–0.71)
Father						
Twin as informant	2,367	0.32	0.25	0.08 (0.00–0.32)	0.23 (0.02–0.35)	0.68 (0.62–0.75)
Co-twin as informant	2,331	0.31	0.12	0.32 (0.11–0.38)	0.00 (0.00–0.17)	0.68 (0.62–0.76)
Average ^a	2,311	0.38	0.24	0.22 (0.00–0.43)	0.15 (0.00–0.36)	0.62 (0.56–0.69)
Authoritarianism						
Mother						
Twin as informant	2,433	0.32	0.11	0.31 (0.14–0.37)	0.00 (0.00–0.14)	0.69 (0.63–0.76)
Co-twin as informant	2,400	0.32	0.13	0.31 (0.11–0.38)	0.00 (0.00–0.17)	0.69 (0.62–0.75)
Average ^a	2,390	0.37	0.15	0.36 (0.17–0.42)	0.00 (0.00–0.17)	0.64 (0.58–0.71)
Father						
Twin as informant	2,377	0.27	0.22	0.09 (0.00–0.32)	0.18 (0.00–0.31)	0.73 (0.66–0.80)
Co-twin as informant	2,334	0.32	0.16	0.32 (0.08–0.39)	0.00 (0.00–0.21)	0.68 (0.61–0.75)

	<i>n</i>	Correlation		Variance (95 % CI)	
		MZ	DZ	a^2	c^2
Average ^a	2,316	0.35	0.22	0.24 (0.00–0.42)	0.12 (0.00–0.32)
					0.64 (0.58–0.72)

MZ monozygotic twin, DZ dizygotic twin, CI confidence intervals

a^2 , additive genetic factors; c^2 , shared environmental factors; e^2 , non-shared environmental factors

^aAver age: Averaged values of parenting reported by twins themselves and their co-twins as informants