Genetic and Environmental Influences on Behavioral Problems and Competences in Very Young Twins

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Abstract

Although genetic and environmental influences on behavior problems in middle childhood and adolescence have been well-studied, little is known about the etiology of behavior problems in very early childhood. The present study explored genetic and environmental contributions to individual differences in behavior problems and competences in an infant-toddler sample of twins. 1950 twin pairs (mean age 23.8 months) were rated by parents on the *Infant-Toddler Social and Emotional Assessment* (ITSEA). All four domains (Externalizing, Internalizing, Dysregulation, Competence) displayed significant heritability. There were also substantial shared environmental influences operating on ITSEA domain scores. Compared to behavior problems, behavioral competencies were less heritable and more influenced by shared environments.

Introduction

- Behavior problems in infancy and toddlerhood have been shown to be stable and clinically significant. Toddlers who display problem behaviors are at risk for of a variety of nonoptimal developmental outcomes including poor academic performance, conflictual parent-child interactions, peer rejection, delinquency, and later maladjustment.
- Despite this, research exploring genetic and environmental influences on behavior problems has focused on middle childhood and adolescence. Behavioral genetic studies of behavior problems in children below age 3 are extremely rare.
- Moreover, the few studies that have examined the etiology of behavior problems in young children have relied almost exclusively on the *Child Behavior Checklist* (CBCL; Achenbach, 1992).
- Analyses of the CBCL indicated that at age 3, genetic factors explain at least 50% of the variance on the two broadband scales of Externalizing and Internalizing. Shared environmental influences were significant, but more modest, explaining no more than a third of the variance for Externalizing and roughly 10% of the variance for Internalizing behaviors (Bartels et al., 2004; Van den Oord, Verhulst & Boomsma, 1996; Van der Valk, Van den Oord, Verhulst & Boomsma, 2001).
- There are, however, hints that shared environmental influences may be more important for younger children. For example, neither the Externalizing, nor Internalizing scales on the CBCL displayed significant heritability in a small sample of 229 twin pairs with a mean age of 2 years (Schmitz, Cherny, Fulker & Marzek, 1994). For both scales, shared environmental influences accounted for more than 40% of the variance.
- The present study extends prior research on the etiology of behavior problems in early childhood in two ways. First, we examine the relative influences of genetic and environmental effects on behavior problems in a large sample of very young twins (mean age 23.8 months). Second, we use a novel measure, the *Infant Toddler Social Emotional Assessment* (ITSEA; Carter, Briggs-Gowan, Jones, & Little, 2003; Carter & Briggs-Gowan, 2006), to assess behavior problems.
- In addition to assessing the broad domains of externalizing and internalizing, the ITSEA includes behaviors related to regulatory problems, and socio-emotional/behavioral competencies, thus giving a fuller picture of socio-emotional development in very young children.

Methods

Sample

- Twins were recruited via "Jumeaux et Plus" ("Twins and More"), a parents of multiples organization in France. The sample included 204 monozygotic male (MZM) and 189 monozygotic female (MZF) twin pairs, 412 dizygotic male (DZM), 390 dizygotic female (DZF) twin pairs and 755 dizygotic opposite (DZO) sex twins.

Procedure

- Parents rated the behaviors of their twins on a French adaptation of the ITSEA, the *Evaluation Sociale et Emotionelle de Jeunes Enfants* (ESEJE; Bracha et al., 2004).
- The ITSEA and its French counterpart consist of 169 items comprising 17 subscales grouped into four domains: *Externalizing*, *Internalizing, Dysregulation*, and *Competence*.
- Items are rated on a 3-point scale: 0 = *Not true/rarely*, 1 = *Somewhat true/sometimes*, and 2 = *Very true/often*. A *"No opportunity"* code allows parents to indicate that they have not had the opportunity to observe certain behaviors (e.g., behavior with peers in daycare).

Analyses

- A sex-limitation model (Figure 1) was fit to observed covariance matrices for each ITSEA domain to estimate genetic and environmental variance components and to evaluate possible sex differences in genetic and environmental contributions to phenotypic variation.
- The A factors refer to additive genetic influences. Based on genetic relatedness, the A factors correlate, as indicated by the r_g paths, 1.0 MZ twins and .5 for same-sex DZ twins. The genetic correlation between opposite-sex twin pairs (r_gO) may be less than .5 if there are *qualitative* sex-specific genetic effects (i.e., different genes operate on the behavior for each sex). This can be estimated in the model.
- The C factors refer to the influence of shared rearing environments on twin resemblance. Because all twins were reared in the same family, the correlation for shared environment (r_c) is 1.0 for same-sex MZ and DZ twins. Opposite-sex twins may have fewer shared environmental experiences than same-sex twins, hence, the correlation for shared environment (r_cO) for DZO twins may be less than 1.0 and can be estimated in the model.
- The E factors reflect nonshared environmental variance and measurement error and, by definition, are uncorrelated.
- The path coefficients, a, c, and e, are partial regressions that indicate the relative influence of the latent variables on the phenotype. As indicated by the m and f subscripts for the path coefficients in Figure 1, the model allows a, c, and e, to be estimated separately for each sex.

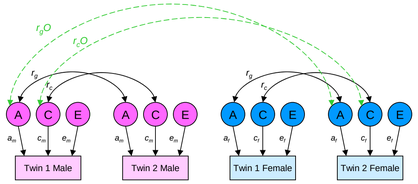

Figure 1. ***The Sex-limitation model.***

- The full sex-limitation model permits qualitative sex differences, *quantitative* sex differences (i.e., differences in the magnitude of genetic and environmental effects), and phenotypic variance differences between the sexes. To test the significance of sex effects, we compared the fit of this model against 3 reduced models:
  1. A ***Common Effects*** model which allows quantitative genetic sex differences.
  2. A ***Scalar*** model which allows only phenotypic variance differences between the sexes.
  3. A ***Null*** model (no sex differences).

Results and Discussion

- ***Twin Intraclass Correlations (Figure 2).*** For each of the ITSEA domains, MZ twins were consistently more similar than DZ twins, suggesting genetic influences. DZ correlations were considerably higher than one-half the MZ correlation, indicating that shared environmental influences also contribute to variability in ITSEA domains. The DZO correlations for Externalizing and Competence were lower than those of same-sex DZ twins suggesting potential qualitative genetic differences between males and females.

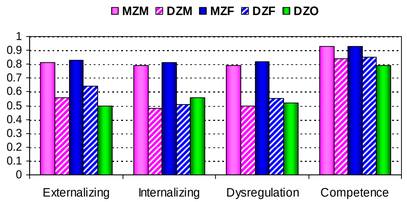

Figure 2. ***Twin Intraclass Correlations***

Table 2. ITSEA Domains: Estimates of Genetic and Environmental Variance (95% Confidence Intervals) and Fit Indices from Best-fitting Model

Domain	Best-fitting model	χ^2	*df*	*p*	AIC	RMSEA		a^2	c^2	e^2	r_gO	Var_m	Var_f
Externalizing	Scalar	22.62	11	.02	0.62	.026		.46 (.38-.54)	.34 (.27-.41)	.20 (.17-.23)		44.67	33.90
Internalizing	Null	16.99	12	.15	-7.01	.009		.50 (.41-.58)	.29 (.21-.36)	.22 (.09-.25)		42.64	42.64
Dysregulation	Null	14.93	12	.25	-9.07	.011		.56 (.48-.65)	.25 (.17-.32)	.19 (.17-.22)		60.40	60.40
Competence	Full r_gO	11.26	8	.19	-4.74	.004	Males	.21 (.16-.27)	.73 (.67-.77)	.06 (.05-.08)	.35 (.17-.49)	98.12	92.07
							Females	.15 (.10-.20)	.78 (.73-.82)	.07 (.06-.09)			

Note. a^2 = genetic variance, c^2 = shared environmental variance, e^2 = nonshared environmental variance. χ^2 = Chi-square fit statistic. *df* = Degrees of freedom. AIC = Akaike's Information Criterion. RMSEA = Root mean square error of approximation. Var_m = Variance of males. Var_f = Variance of females.

Model-fitting Results (Table 2)

Sex differences

- There were few differences in the etiology of the four ITSEA domains. The null model, which equates males and females for all parameters, was the best-fitting model for both Internalizing and Dysregulation. For Externalizing, the scalar model provided the best fit to the data, indicating that there was a sex difference in phenotypic variance (males higher than females), but not in the *proportion* of variance that was accounted for by genetic and environmental factors.
- Competence was the only ITSEA domain to display a significant sex difference at the level of etiology. The best-fitting model was the full sex-limitation model which allows for quantitative and qualitative genetic differences between males and females. The genetic correlation between DZO twins (r_g = .35) was significantly lower than that for DZ same-sex twins (r_g = .50). Males and females, however, did not significantly differ in the magnitude of genetic and environmental variance. Thus, the sex difference for Competence appears to be solely qualitative in nature and suggests that to some extent different genes may be operating across the sexes.

Variance Components

- For the three behavior problem domains, genetic factors explained approximately 50% of the variance. Shared and nonshared environmental influences were also significant, but more modest for these domains. In contrast, genetic factors contributed only modestly to the variability for the Competencies domain, whereas shared environmental influences were substantial explaining over 70% of the variance.

Conclusions

- The results for externalizing and internalizing behaviors are remarkably consistent with previous research, thus providing strong evidence for the role of genetic and environmental influences on externalizing and internalizing behaviors in very early childhood. The present study extends these findings to problems of dysregulation.
- The etiology of socio-emotional competencies in very early childhood differs considerably from that of behavior problems. Our findings of prodigious shared environmental influences on behavioral competencies would be consistent with parenting research in early childhood and suggests that there are family-wide effects that influence the development of behavioral competencies and thus make young siblings similar within this behavioral domain.

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