Published in final edited form as:
Infant Child Dev. 2012 ; 21(1): 85–106. doi:10.1002/icd.764.

The Association between Positive Parenting and Externalizing Behavior[1]

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Abstract

The present study examined the role of positive parenting on externalizing behaviors in a longitudinal, genetically informative sample. It often is assumed that positive parenting prevents behavior problems in children via an environmentally mediated process. Alternatively, the association may be due to either an evocative gene-environment correlation, in which parents react to children's genetically-influenced behavior in a positive way, or a passive gene-environment correlation, where parents passively transmit a risk environment and the genetic risk factor for the behavioral outcome to their children. The present study estimated the contribution of these processes in the association between positive parenting and children's externalizing behavior. Positive parenting was assessed via observations at ages 7, 9, 14, 24, and 36 months and externalizing behaviors were assessed through parent report at ages 4, 5, 7, 9, 10, 11, and 12 years. The significant association between positive parenting and externalizing behavior was negative, with children of mothers who showed significantly more positive parenting during toddlerhood having lower levels of externalizing behavior in childhood; however, there was not adequate power to distinguish whether this covariation was due to genetic, shared environmental, or nonshared environmental influences.

Introduction

Externalizing behaviors encompass aggressive, delinquent, and hyperactive behaviors. Childhood externalizing behavior problems interfere not only with a child's development but also with family functioning (Fossum, Morch, Hadegard & Drugli, 2007; Frick & Jackson, 1993). In addition, early behavior problems are a risk factor for later juvenile delinquent behavior and adult crime (Moffitt, 1993). For some children, externalizing behaviors are a normal stage of development that eventually remit; however, there is a

[1]This study was supported by the MacArthur Foundation and NIH grants HD50346, HD10333, MH 16880, and DA11015. Coding scheme for mother-child interactions was developed by E G Bishop. Support for coding was funded by MH48980 awarded to Dr. Lisabeth F. DiLalla. Support for original videotape data collection was funded by HD18426 and HD19802 awarded to Dr. David W. Fulker. We thank the Longitudinal Twin Study investigators, Corinne Wright, Sally Ann Rhea, and the LTS participants and research assistants. Preliminary results were presented at the annual meeting of the Association for Psychological Science in May 2009 in Chicago, IL, the annual meeting of the Association for Behavioral and Cognitive Therapy in November 2009 in Orlando, FL, and the biennial meeting of the Society of Research and Child Development in April 2009 in Denver, CO.

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subset of children with chronic, stable externalizing symptoms (Kerr, Lopez, Olson & Sameroff, 2004). The current study focuses on understanding the protective factors that prevent the development of externalizing behaviors. More specifically, we examined whether the positive parenting behaviors displayed by mothers during toddlerhood act as a protective factor against lower levels of externalizing behavior in later childhood. Also, we examined the genetic and environmental influences on the association between positive parenting behaviors and later child externalizing behavior.

We expected parenting during the toddler period to be particularly important because this is an age at which parenting may become more responsive to child effects. For example, a review by Keenan and Shaw (1997) suggests that while differences in parenting of boys and girls are limited during infancy, they emerge during toddlerhood (with parents putting forth more effort in parenting of girls). Also, sex differences in externalizing behavior first emerge around age 4 (with boys starting to have greater levels of externalizing behavior).

One important predictor of externalizing behavior is quality of parenting. (Olson et al., 2000; Narusyte, Andershed, Neiderhiser & Lichtenstein, 2007). Exposure to harsh and punitive parenting behaviors during early development negatively influences offspring behavior and is associated with aggressive behaviors (McKee et al., 2007, Weiss, Dodge, Bates, & Pettit, 1992). Maternal negativity has been shown to predict adolescent externalizing behavior in both boys and girls (Kim, Hetherington, & Reiss, 1999). Patterson and colleagues (Patterson, Reid, & Dishion, 1992) also suggest that ineffective discipline such as scolding and lack of monitoring results in increased behavior problems in children and antisocial behaviors in adolescents.

In understanding the etiology of externalizing behavior, it is important to consider not only risk factors such as the presence of negative parenting behaviors but also protective factors such as positive parenting behaviors, as the absence of positive parenting is as important as the presence of negative parenting in the development of behavior problems (Pettit & Bates, 1989). Although there is a larger body of research that has investigated the detrimental effects of negative parenting, several studies have also found possible protective effects of positive parenting. Children of mothers who display affection and positive interest have lower levels of aggression and disruptive behaviors (McFadyen-Ketchum, Bates, Dodge, & Pettit, 1996). Chronis and colleagues (2007) found that children of mothers who displayed the highest level of positive parenting during the initial observation showed lower levels of conduct problems in subsequent years of the study. In addition, high maternal warmth in the presence of high paternal physical discipline is associated with fewer disruptive behaviors (McKee et al., 2007). Low maternal warmth has been shown to be associated with higher child externalizing behaviors and moderates the relationship between harsh physical discipline and child externalizing problems (Deater-Deckard, Ivy, & Petrill, 2006; Deater-Deckard & Dodge, 1997).

Treatment studies also emphasize the importance of positive parenting techniques. The most well-established treatments for child and adolescent conduct problems are parent training programs, specifically Parent Management Training (Brestan & Eyberg, 1998; Kazdin & Weisz, 2003; Woolfenden, Williams, & Peat, 2002). Gardner and colleagues (2006) used the Webster-Stratton parenting program in order to enhance praise, incentive, problem solving, and discipline in interactions between parents and their children, and found that an increase in positive parenting behaviors mediated change in observed child behavioral problems. Although these studies clearly indicate that an environmental change in parenting can lead to a change in child externalizing behavior, treatment studies are not informative regarding the etiology of the naturally occurring association between positive parenting and children's behavior in the general population.

Parenting is often assumed to be an environmental variable that affects behavioral outcomes in children directly; however, alternative explanations exist. It is possible that the association between positive parenting and behavioral outcomes is due to common influences, such as shared genes. More specifically, the association between parenting and behavioral outcomes may be due to gene-environment correlation. Understanding genetic and environmental influences on positive parenting may help us understand the influence of parent vs. child effects on positive parenting and the association between positive parenting and externalizing behavior.

There are three types of gene-environment correlations: passive, active, and evocative (Neiderhiser et al., 2004;Plomin, DeFries & Loehlin, 1977; Scarr & McCartney, 1983). Passive genotype-environment correlation occurs when parents passively transmit a risk environment and the genetic risk factor for the behavioral outcome to their children. Evocative genotype-environment correlation results when the environment is a response to a child's genetic characteristics. For example, a parent may respond negatively to a child's difficult temperament, which is influenced by genetic factors. Active genotype-environment correlation occurs when a child seeks out certain environments that are consistent with his or her genetic characteristics. In passive gene-environment correlation, the parent's genes are correlated with the environment, and in evocative and active gene-environment correlation, there is a correlation between a child's genes and environmental influences.

Genetically informative studies, such as twin studies, are useful in testing alternative hypotheses regarding the association between a putatively environmental influence, such as parenting, and child outcomes. Twin studies allow researchers to estimate the magnitude of genetic and environmental influences on the phenotype of positive parenting and child outcomes. Comparing the similarity between monozygotic twins, who share 100% of their genes, and dizygotic twins, who share 50% of their segregating genes on average, helps disentangle the extent to which a trait is influenced by genes, shared environmental influences (i.e., environmental influences that family members share and that make them more similar on a particular trait), or nonshared environmental influences (i.e., environmental influences that make family members more dissimilar on a trait). These three components help explain the observed variance of a phenotype. A greater correlation between monozygotic (MZ) twins than dizygotic (DZ) twins suggests genetic influences (A). In contrast, a DZ correlation that is more than half the MZ correlation suggests shared environmental influences (C). A MZ correlation less than one suggests nonshared environmental influences (E).

Genetically informative studies examining gene-environment correlations use either a child-based or parent-based design (Neiderhiser et al., 2004). In a child-based design, the child's genes are the unit of measurement and children of different relatedness participate (e.g., a study of MZ and DZ children). In a parent-based design, the parents' genes are examined and the influence of parental genes on how they parent is examined (e.g., a study of MZ and DZ parents). In a genetically informative study of a putatively environmental influence, the interpretation of genetic, shared environmental, and nonshared environmental influences must be modified to take into account passive or evocative gene-environment correlation.

In a study using a child-based design (i.e., a study examining the parenting of MZ and DZ children), which is the more common design (and the design used in the present study), the presence of genetic influences suggests that MZ twin pairs are experiencing more similar parenting than DZ twin pairs. Additive genetic influences, referred to as A, represent the variance in parenting that is due to the child characteristics which are genetically influenced (and therefore represent evocative or active gene-environment correlation). Shared, or common, environmental influences, referred to as C, represent how similarly parents treat

their children, regardless of the genetic similarly of the children (i.e., whether they are MZ or DZ twin pairs). Evidence of shared environmental influences on a putatively environmental variable is evidence of either environmental mediation and/or the influence of the parents' genotype (i.e., passive gene-environment correlation); both can result in parents treating the two twins similarly. Lastly, the nonshared environmental factor, referred to as E, reflects differences in the parenting of siblings that are mediated by the environment not shared between the siblings (such as birth trauma affecting only one of the siblings) and not predicted by genetics or family background; it could also reflect measurement error (e.g. errors in rating positive parenting).

Behavior genetic studies suggest that there are significant genetic influences on putative environmental influences, such as positive parenting. Kendler and Baker's (2007) review concluded that genetic influences on putatively environmental influences are pervasive, suggesting that researchers should not assume a unidirectional relationship between the environmental influences and outcomes. Kendler and Baker's review included studies examining several parenting variables and concluded that positive parenting was more heritable than control and protective styles of parenting, with heritability being highest for parental warmth and lowest for parental control and negativity. This finding emphasizes the importance of examining possible genetic influences on positive parenting, especially parental warmth, and exploring genetic hypotheses regarding the association between positive parenting and children's behavior. These results are not entirely consistent across the literature. For example, Reiss and colleagues (2000) examined the role of family relationships in adolescent development and compared maternal positivity and maternal negativity. They found lower heritability and higher shared environmental influences on maternal positivity in comparison to maternal negativity. In addition, the correlation between maternal negativity and adolescent antisocial behavior was explained by shared environmental influences.

Several genetically informative studies found evidence for evocative gene-environment correlation in the relation between negative parenting and externalizing behavior (e.g., Burt et al., 2005; Ge et al., 1996; Larsson et al., 2008; Neiderhiser et al., 1999; O'Connor et al., 1998, Schulz-Heik, Rhee, Haberstick, Hopfer, Lessem, & Hewitt, 2010) and evidence of bidirectional effects in the relation between negative parenting and externalizing behavior (e.g., Burt et al., 2005; Larsson et al., 2008). In contrast, to our knowledge, there are fewer genetically informative studies examining the association between positive parenting and externalizing behavior. In addition to Reiss and Colleagues (2000), Deater-Deckard (2000) examined the association between a maternal warmth composite (measured by affection, positive mother-child relationship, how well a mother knows her child, and her enjoyment of parenting) and conduct problems. The study found evidence of genetic influences in the association between the positive parenting composite variable and child disruptive behavior, and concluded that there was evidence of evocative gene-environment correlation (or children's genetically influenced disruptive behavior having a negative effect on maternal warmth). Deater-Deckard and Petrill (2004) examined a parent-child dyadic mutuality construct consisting of parent responsiveness, child responsiveness, cooperation, and joint attention. The correlation between parent mutuality and behavior problems was not significantly different in biological and adoptive child-parent pairs, leading the authors to conclude that there was no evidence of passive gene-environment correlation (i.e., the association between mutuality and behavior problems is not due to common parental genetic influences).

The present longitudinal study examined the etiology of positive parenting, externalizing behaviors, and the covariance between positive parenting and externalizing behavior, estimating the magnitude of genetic (i.e., evocative gene-environment correlation), shared

environmental (i.e., passive gene-environment correlation and/or environmental mediation), and nonshared environmental influences (i.e., environmental mediation and measurement error). We examined the relation between several positive parenting measures obtained from age 7 to 36 months and child externalizing behavior assessed at several time points from age 4 to 12. The use of two different assessment methods (observations of positive parenting and parent reports of externalizing behavior) helped ensure that the association between parenting and externalizing would not be due to measurement covariance. We examined sex differences in the association between positive parenting and externalizing behavior, as on average, boys display higher levels of externalizing behavior than girls (e.g., Keenan & Shaw, 1997; Kerr et al., 2004; Mesman, Bongers & Koot, 2001; Smeekens, Riksen-Walraven & van Bakel, 2007), and some studies suggest that parents treat boys more negatively than girls (e.g., Mahoney et al, 2000; McKee, 2007; Shaw, Keenan & Vondra, 1994 ; Straus & Stewart, 1999).

Methods

Participants

Participants were same-sex twin pairs recruited through the Colorado Department of Health born between 1984 and 1990 in Colorado. Rhea and colleagues (Rhea, Gross, Haberstick, & Corley, 2006) provide detailed information and criteria used for the recruitment of participants. The current analyses utilized combined data from two overlapping twin samples described in Rhea et al. (2006), the Twin Infant Project (TIP) and the Longitudinal Twin Study (LTS). Ninety-five percent of the TIP parent sample is Caucasian, and the mean number of years of education is 14.10 for mothers and 14.63 for fathers. Similarly, approximately 86% of the LTS sample is Caucasian, and the mean number of years of education is 14.29 for mothers and 14.42 for fathers.

The present study examined the association between positive parenting in toddlerhood (assessed by the TIP) and externalizing behavior in childhood (assessed by the LTS). Positive parenting in the current sample was measured in mothers only. Paternal parenting was not assessed. The overall sample (i.e., participants with positive parenting data, externalizing behavior data, or both at any of the assessments) consists of 942 toddlers (472 girls and 470 boys; 510 MZ twins and 432 DZ twins). Parenting data were available for 438 participants, externalizing data were available for 849 participants, and 391 participants had both parenting and externalizing data. Table 1 presents the number of participants with parenting and externalizing data at each age.

Measures and Procedures

The twins participating in the TIP (DiLalla et al., 1990) were administered a battery of measures at ages 5, 7, 8, and 9 months. Home testing at 7 and 9 months included a videotaped mother–child interaction in which mothers spent 2.5 minutes eliciting vocalizations from the child. This interaction was conducted toward the end of testing after parents and children were familiar with the testers and were used to the testing situation, and testers were not present in the room during the interaction. The twins participating in the LTS (which overlaps with TIP) were also videotaped at 14, 24, and 36 months; during the home visit, mothers were asked to teach their children a sorting task. These interactions were triadic, with both twins and their mother engaging in the sorting tasks together. Two sorting toys were provided, one for each child, so that children could work together or separately. In addition, at 36 months, mothers also worked in dyads with each twin individually. Again, testers were not present during the interaction, which proceeded after families were comfortable with the testing situation. The LTS twins' videotapes at age 14,

24, and 36 months were coded if they were also in the TIP and had participated in the mother–child interactions at age 7 and 9 months.

Innovative observational coding of parenting behaviors provided a systematic approach to quantify both positive and negative interactions between mother and child. This coding was accomplished through both microanalytic ratings of each behavior and an overall global rating of each interaction (DiLalla & Bishop, 1996; Mullineaux, & DiLalla, 2007). Videotapes from the mother–child interactions were used to code parenting behaviors at 7, 9, 14, 24, and 36 months. Microanalytic coding rated each mother and infant behavior that occurred during the 2.5-minute interaction. The mother behaviors coded were “time spent trying to get the infant to hold and touch a toy”, “time spent holding or touching the child affectionately”, “verbally acknowledging the infant’s vocalizations”, and “time spent verbally eliciting vocalizations from the infant”. A global coding scheme also was used to code the information a second time and capture the interaction as a whole. The coding systems were developed by DiLalla and Bishop (1996) and based in part on a rating system by Pianta and Castaldi (1990). Five mother behaviors were rated on a 5-point Likert scale during the 2.5 minute interaction between mother and infant. The mother scales were “respect for the child’s autonomy”, “quality of instruction”, “sensitivity to cues from the child”, “warmth”, and “overall interaction with infant”. Each twin was rated by a separate coder, and the inter-rater reliability ranged from .74 to .90.

Among all possible microanalytic and global parenting variables, the parenting variables that were correlated with the other parenting variables consistently at each age (i.e. the global codes warmth, sensitivity, quality of instruction and overall interaction; correlations ranged from .51 to .71) were selected for further analyses. None of the microanalytic codes met this criterion.

Table 2 presents the correlations among the selected parenting variables across time points. These longitudinal correlations are small and sometimes negative; however, each observation provides a very brief snapshot of parenting at each time point, which is one of the criticisms of genetic studies of observations of putatively environmental influences (e.g., Baker & Kendler, 2007). Therefore, the parenting variables were averaged across age in order to reduce the total number of variables and to increase reliability of the parenting measure.

The Child Behavior Checklist (CBCL; Achenbach, 1991) was completed by mothers when the twins were 4, 5, 7, 9, 10, 11, and 12 years old. The CBCL is a parent questionnaire designed to assess 8 behavior scales. The scale relevant to the current study examining disruptive behaviors was the externalizing behavior scale.

Log transformations were conducted when skewness or kurtosis were above one (only externalizing behavior variables required transformation). In addition, given gender differences in the mean level of both positive parenting (boys = −.10; girls = .09; $t(436)=2.50$, $p=.01$) and externalizing behavior (boys= .18; girls= −.11; $t(847) = -4.99$, $p<.01$), Z-scores for parenting and externalizing behavior variables were calculated within each gender.

Zygosity determination

The zygosity status of both the TIP and LTS twins was determined by the testers at each age. A modified version of the Nichols and Bilbro (1966) questionnaire was used to make a judgment of zygosity, and tester agreement was compared. For the TIP sample, participants had to complete at least two sessions and raters had to have 100% agreement on the four ratings of zygosity. The LTS sample required 85% agreement from a minimum of four

raters. Twin pairs who were rated highly similar were rated as MZ, whereas twin pairs who were rated somewhat similar on two characteristics or not at all similar on one characteristic are rated as DZ. In addition, buccal cells were obtained and 11 short tandem repeat polymorphisms were genotyped to confirm zygosity for 92% of the sample.

Analyses

The structural equation modeling program Mplus (Muthen & Muthen, 2004) was used to conduct exploratory and confirmatory factor analyses of the positive parenting variables and externalizing behaviors from ages 4 to 12 years. Mplus takes into account non-independence of observations and treats missing data as missing at random. First, we conducted exploratory factor analyses (EFA) to determine whether all positive parenting items loaded on a single latent variable representing positive parenting. Similarly, a separate EFA was conducted to determine whether externalizing behaviors from ages 4 to 12 loaded on a single latent variable representing externalizing behaviors. Then, a confirmatory factor analysis (CFA) was conducted to test a model with a latent positive parenting factor, a latent externalizing behavior factor, and a correlation between the two latent factors. The factor loadings for positive parenting and externalizing behavior are presented in Figure 1 A chi-square test was used to determine the fit of the model; however, given the chi-square test's sensitivity to large sample sizes, three additional model fit indices, the Comparative Fit Index (CFI; Bentler, 1990), the Tucker-Lewis Index (TLI; Bentler, 1990) and the Root Mean Square Error of Approximation (RMSEA; Browne & Cudeck, 1993), were examined. A CFI and TLI greater than 0.9 (Hu & Bentler, 1998) and a RMSEA less than 0.08 (Browne & Cudeck, 1993) suggest an adequate fit.

Mx (Neale, 1997) was used to test biometrical genetic analyses examining the magnitude of genetic (A), shared environmental (C), and nonshared environmental (E) influences on positive parenting, externalizing behavior, and the covariance between positive parenting and externalizing behavior. Mx also treats missing data as missing at random.

Twin studies take advantage of the fact that MZ and DZ twins share the same environment, but share different proportions of their genes. MZ twins share 100% of their genes while DZ twins share, on average, 50% of their genes identical by descent. Genetic influences are suggested when the magnitude of the correlation is greater for MZ twins than DZ twins. Shared environmental influences are implied when the DZ correlation is greater than half the MZ correlation. Nonshared environmental influences and/or measurement error are suggested when the MZ twin correlation is less than 1.0. Plomin and colleagues (2008) provide further information about the assumptions made in twin modeling. For example, the equal environment assumption suggests that environmentally caused similarity between twins does not vary between MZs and DZs.

First, a multivariate Cholesky model was used to examine the covariance between parenting variables and child externalizing variables. The Cholesky model was the most unrestricted model tested used to examine the magnitude of genetic, shared environmental, and nonshared environmental influences on the covariation among all parenting and externalizing variables. The first factor influences all of the variables, the second factor influences all but the first variable, the third factor influences all but the first two variables, and so on.

Second, a bivariate common pathway model was fit to the data to examine the covariance between the parenting and child externalizing behavior latent variables (see Figure 2). This model includes a latent parenting factor and a latent child externalizing factor that are each influenced by common genetic, shared environmental, and nonshared environmental influences, as well as variable-specific genetic, shared environmental, and nonshared

environmental influences. A series of nested models tested the statistical significance of genetic, shared environmental, and nonshared environmental influences on the covariation between parenting and child externalizing behavior. In the full model, all parameters are freed or not constrained, whereas the nested models drop or constrain a parameter (or parameters) from the full model. A likelihood ratio test is used to compare the fit of the nested model and full model, where the difference in the −2LLs of the two models is treated as a χ^2 distribution and the difference in the number of estimated parameters is treated as a change in degrees of freedom. A significant χ^2 (p<.05) indicates a decrement in fit of the nested model, and therefore is rejected in favor of the full model. In contrast, the dropped parameter is not considered a salient component of the model when the χ^2 is non-significant. In addition, the fit of each model was compared using the Akaike Information Criterion (AIC; Akaike, 1987), calculated as $\chi^2 - 2df$. The AIC takes into account both model fit and parsimony. The model with a lower AIC is the better-fitting, more parsimonious model.

Results

Factor Analysis

Table 3 presents the phenotypic correlations among the parenting and among child externalizing behavior variables. These correlations were moderate to substantial. All of the correlations among the four parenting variables were significant, with $p < .01$, for all twins (.41–.72), girls (.32–.70), and boys (.44–.73). Also, all phenotypic correlations among externalizing behavior assessed from ages 4 to 12 were statistically significant for all twins (.44–.80), girls (.49–.81), and boys (.36–.80).

The results of EFA suggest that the parenting variables (sensitivity, quality of instruction, warmth, and overall mother–child interaction) load onto a single factor (with factor loadings from .47 to .88), and child externalizing behavior from ages 4 to 12 also load onto a single factor (with factor loadings from .67 to .89), given that there was only one eigenvalue greater than one. Results were similar when EFAs were conducted separately for boys and girls, with similar factor loadings, for parenting (.53–.88 for girls and .62–.90 for boys) and child externalizing behavior (.73–.88 for girls and .61–.91 for boys).

The CFA model examining the correlation between a latent parenting factor and the latent externalizing behavior fit adequately ($\chi^2(43) = 211.340$, $p < .01$; CFI = 0.93, RMSEA = 0.066) (see Figure 1). All parenting variables had significant loadings ($p < .01$) on the latent parenting factor, and all externalizing behavior variables had significant loadings ($p < .01$) on the latent externalizing behavior factor. The correlation between the parenting latent factor and the externalizing behavior latent factor was modest but statistically significant ($r = -.18$, $p < .01$), suggesting that more positive parenting during infancy and toddlerhood is associated with fewer childhood externalizing behaviors.

Confirmatory factor analyses also were conducted separately for boys and girls. These results are presented in Figure 1. For both boys and girls, all parenting variables had significant loadings ($p < .01$) on the latent parenting factor, and all externalizing behavior variables had significant loadings ($p < .01$) on the latent externalizing behavior factor. The correlation between positive parenting and externalizing behavior was negative in both boys ($r = -.09$, $p = .38$) and girls ($r = -.24$; $p < .01$); however, it was statistically significant only in girls. On the other hand, a model constraining the parameters in the model to be equal between boys and girls did not lead to a significant decrement in fit ($\chi^2(21) = 17.01$, $p = .71$).

We also examined the correlation between the parenting latent factor and externalizing behavior at age each. Although the correlation was not significant at every age, it was consistently negative, with the exception of age 7 externalizing behavior in boys (see Table 4).

The within-trait cross-twin (i.e., correlations between twin 1 and twin 2 for the same variable) and cross-trait cross-twin (i.e., correlations between twin 1 and twin 2 for different variables) correlations were calculated for MZ and DZ twin pairs for positive parenting, externalizing behavior, and the covariance between positive parenting and externalizing behavior (see Table 5). We presented the correlations for the mean parenting and mean externalizing variables given the large number of variables (four parenting variables and seven externalizing behavior variables), and because the factor analysis results suggest that the four parenting variables load significantly on a single latent parenting factor and the seven externalizing variables load significantly onto a single latent externalizing behavior factor.

In the entire sample, the within-trait cross-twin correlation for parenting was similar in MZs and DZs, suggesting shared environmental influences. That is, parents treat their children similarly regardless of the children's genetic similarity. This result suggests possible environmental mediation or effects of parental genotype (i.e., passive gene-environment correlation). In contrast, the cross-trait cross-twin correlation (for parenting and externalizing behavior) was slightly higher in MZs than in DZs, suggesting possible genetic influences. This cross-trait cross-twin correlation suggests the effects of the children's genotype (i.e., evocative gene-environment correlation). In boys, both the within-trait cross-twin correlation (for parenting) and the cross-trait cross-twin correlation (for parenting and externalizing behavior) is higher in MZs than in DZs, suggesting possible evocative gene-environment correlation. In girls, the within-trait cross-twin DZ correlation is greater than the MZ correlation for positive parenting, and the MZ and DZ cross-trait cross-twin correlations (for parenting and externalizing behavior) are similar, suggesting environmental mediation or passive gene-environment correlation. For child externalizing, the MZ twin correlations were greater than the DZ twin correlations for the total sample, boys, and girls.

Biometrical Models

The Cholesky model had a $-2\ log\ likelihood$ of 11192.65 with 4934 degrees of freedom and an AIC of 1324.52, whereas the bivariate common pathway model had a −2 log likelihood of 11714.744 and 5279 degrees of freedom and an AIC of 1156.744. The bivariate common pathway model had a lower AIC than the Cholesky model, suggesting that the bivariate common pathway model is the more parsimonious model.

The bivariate common pathway model that constrained parameters to be equal across sexes (−2 LL = 11724.651, df = 5279, AIC = 1166.651) did not fit worse than the model in which parameter estimates were free to vary (−2LL = 11660.886, df = 5228, AIC = 1204.886). However, we decided to present the data for boys and girls separately also (as well as for the entire sample), given that boys had significantly lower levels of positive parenting and higher levels of externalizing behavior than girls, and the phenotypic correlation between positive parenting and externalizing behavior was statistically significant only in girls.

The bivariate common pathway model was conducted for the entire sample, and separately for boys and girls (see Figures 2 and 3). The parameter estimates from the bivariate common pathway model were used to determine the magnitude of genetic, shared environmental, and nonshared environmental influences on the variance of positive parenting, variance of externalizing behavior, and the covariation between positive parenting and child externalizing factors. For the entire sample, the variance of externalizing behavior shared in

common with positive parenting and the covariation between positive parenting and externalizing behavior seemed to be influenced by both genetic and shared environmental influences, whereas they were due mostly to genetic influences in boys and mostly to shared environmental influences in girls (see Table 6).

Table 7 presents the results of the common pathway models conducted to examine statistical significance of common genetic, shared environmental, and nonshared environmental influences between positive parenting and child externalizing behavior. Dropping the common genetic, shared environmental, and nonshared environmental influences one at a time did not result in a significant decrement in the fit of the model, although all three could not be dropped at the same time, indicating that there was inadequate power to determine whether the association between positive parenting and externalizing behavior is due to common genetic, shared environmental, or nonshared environmental influences. In boys, dropping the common genetic, shared environmental, and nonshared environmental influences (or dropping all three at the same time) did not lead to a significant decrement in fit. In girls, there were statistically significant common shared environmental influences.

Discussion

Understanding the role of parenting is critical in the study of both risk and protective factors in the development of child externalizing behavior. The present study is one of the first to use a prospective, longitudinal, and genetically informative sample to examine whether positive parenting during infancy/toddlerhood is a protective factor against externalizing behavior in childhood. The present study took advantage of multiple assessments across time for both positive parenting and child externalizing behaviors, allowing us to examine the relation between latent positive parenting and externalizing factors, which are less affected by measurement error. We examined a latent construct of parenting across toddlerhood and a latent construct of externalizing behavior across childhood, which means that we are examining phenotypes that capture parenting and externalizing that are common or stable across time. Positive parenting or externalizing behavior that is specific to a single time point is not captured in the latent constructs and developmental changes are not considered. We did not address whether there are developmental changes in parenting; we averaged parenting behaviors across the ages in this study given the methodological weaknesses of brief snapshots of observed parenting. Finally, any association between positive parenting and child externalizing behavior cannot be due to shared method variance, as positive parenting was measured via observations, and child externalizing behaviors were measured via maternal report.

Positive parenting was assessed during multiple mother–child interactions from ages 7 to 36 months, and externalizing behavior was assessed from ages 4 to 12 years via parent ratings. Higher levels of positive parenting by mothers during infancy and toddlerhood predicted lower levels of externalizing behavior during later childhood ($r = -.18$, $p < .01$), supporting previous studies which suggest that positive parenting serves as a protective factor against externalizing behavior (e.g., Chronis et al., 2007; Deater-Deckard & Dodge, 1997; Deater-Deckard, Ivy, & Petrill, 2006; McFadyen-Ketchum, Bates, Dodge, & Pettit, 1996). The association between the latent parenting factor and externalizing behavior at each age was consistently negative (see Table 4).

Boys displayed higher mean levels of externalizing behavior and received lower levels of positive parenting. The higher level of externalizing behavior reported in boys than girls is a consistent finding in the literature (e.g., Keenan & Shaw, 1997; Kerr et al., 2004; Mesman, Bongers & Koot, 2001; Moffitt, Caspi, Rutter & Silva, 2001; Smeekens, Riksen-Walraven, & van Bakel, 2007). Several previous studies have found that boys receive more negative

parenting than girls, with boys receiving more corporal punishment and harsher discipline than girls (Mahoney et al, 2000; McKee et al, 2007; Straus & Stewart, 1999), although the few studies that examined positive parenting did not find sex differences (e.g., Chronis et al, 2007; Deater-Deckard, 2000).

Biometrical genetic models were fit to determine the contribution of genetic, shared environmental and nonshared environmental influences on the covariation between positive parenting and externalizing behavior. Additive genetic influences represent the variance in parenting that is due to the child characteristics which are genetically influenced, and shared environmental influences represent how similarly parents treat their children. Evidence of shared environmental influences on a putatively environmental variable is evidence of either environmental mediation and/or the influence of the parents' genotype. Lastly, the nonshared environmental factor reflects measurement error and differences in the parenting of siblings that are mediated by the environment not shared between the siblings and not predicted by genetics or family background. In the present study, although the overall covariation between positive parenting and externalizing behavior was statistically significant, there was not adequate power to distinguish whether this covariation was due to genetic, shared environmental, or nonshared environmental influences.

The model parameters were not statistically different for boys and girls. We examined the results for boys and girls separately also, given that boys had significantly lower levels of positive parenting and higher levels of externalizing behavior than girls, and the phenotypic correlation between positive parenting and externalizing behavior was statistically significant only in girls. The covariation between positive parenting and externalizing behavior was due mostly to genetic influences in boys and to shared environmental influences in girls; that is, in boys, the association between positive parenting and externalizing behavior was greater in MZs than in DZs, whereas in girls, it was similar for MZs and DZs. However, as noted above, the parameters were not statistically different for boys and girls and should be interpreted with caution.

We found an association between positive parenting measured very early in development and later antisocial behavior. However, these results do not necessarily suggest that there is a critical period for positive parenting. It is possible that positive parenting is stable, and that contemporaneous positive parenting is also associated with externalizing behavior. However, we cannot address this question in the present study, as we did not have consistent measurements of positive parenting throughout development. Studies examining parenting across development need to be conducted to elucidate whether a critical period exists.

Small sample size is a limitation of the current study. Although genetically informative samples provide the opportunity to examine the magnitude of genetic (i.e., evocative gene-environment correlation), shared environmental (i.e., passive gene-environment correlation and/or environmental mediation), and nonshared environmental influences (i.e., environmental mediation and measurement error) on the covariance between positive parenting and externalizing behavior, the present study did not have adequate power to distinguish among these. Larger, genetically informative studies with power to examine potential gender differences are needed.

A potential limitation of the positive parenting assessment was that the examination of triadic interactions (i.e., examining both twins with their mother simultaneously) may have reduced the impact of the children's genetically influenced behavior on positive parenting. Also, the assessment of positive parenting was limited to mother-child interaction. Examining father-child interactions in the future may be important, as a meta-analysis

suggests that paternal support may be more strongly related to the development of delinquent behavior than maternal support (Hoeve et al., 2009).

The present study examined observations of parenting. This is a strength, as observations are less likely to be biased, and the association between parenting (assessed via observations) and externalizing behavior (assessed via parent report) cannot be due to method covariance. However, observations only provide snapshots of parenting, and the correlations between positive parenting across time were small. Also, Kendler and Baker (2007) noted in their review that the heritability of putatively environmental measures (such as positive parenting) differed by assessment method, with the evidence for genetic influences being greater for self or informant report than for observations. Future studies employing a multi-method approach to assessing parenting would be helpful.

There are several limitations in the existing studies examining positive parenting as a protective factor against child externalizing behavior, indicating potential future directions. The definition of positive parenting varies across studies and encompasses a variety of specific parenting behaviors. More consistency in the operational definition of positive parenting across studies would be helpful. Also, additional research examining the effects of both positive and negative parenting simultaneously is needed. For example, McKee et al. (2007) found that maternal warmth in an environment of high paternal physical discipline was associated with fewer disruptive behaviors. Finally, additional studies examining the role of child temperament as a possible moderator are needed. For example, Bradley and Corwyn (2008) found that there is a reduction of externalizing behaviors in the presence of maternal sensitivity in children with difficult temperaments, but not in children with easy temperaments.

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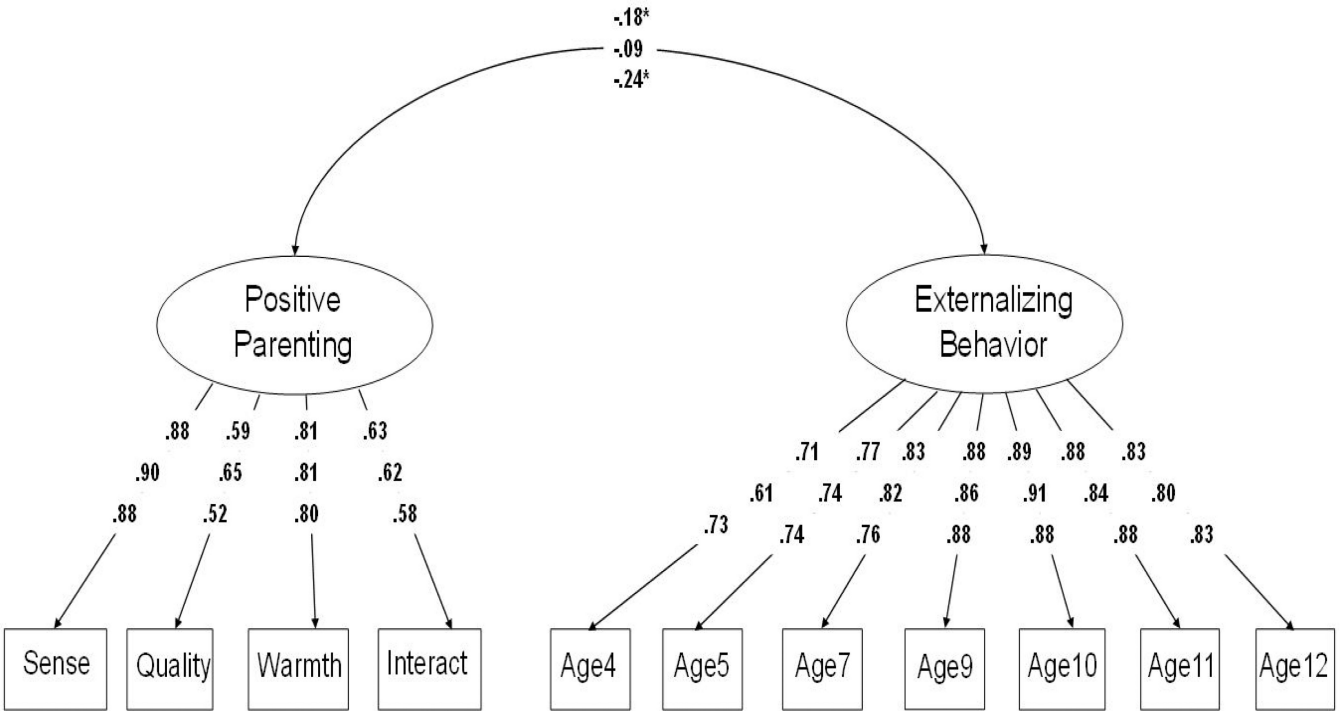

Figure 1.

Results of confirmatory factor analyses with separate factors for Positive Parenting and Externalizing Behavior. sense = maternal sensitivity; quality = maternal quality of instruction; warmth = maternal warmth; interact= overall rating of mother–child interaction. Results for the full sample are presented by the top numbers, results for boys are presented by the middle numbers, and results for girls are presented by the bottoms numbers. All parenting variables had significant loadings ($p < .01$) on the latent parenting factor, and all externalizing behavior variables had significant loadings ($p < .01$) on the latent externalizing behavior factor. * $p<.01$

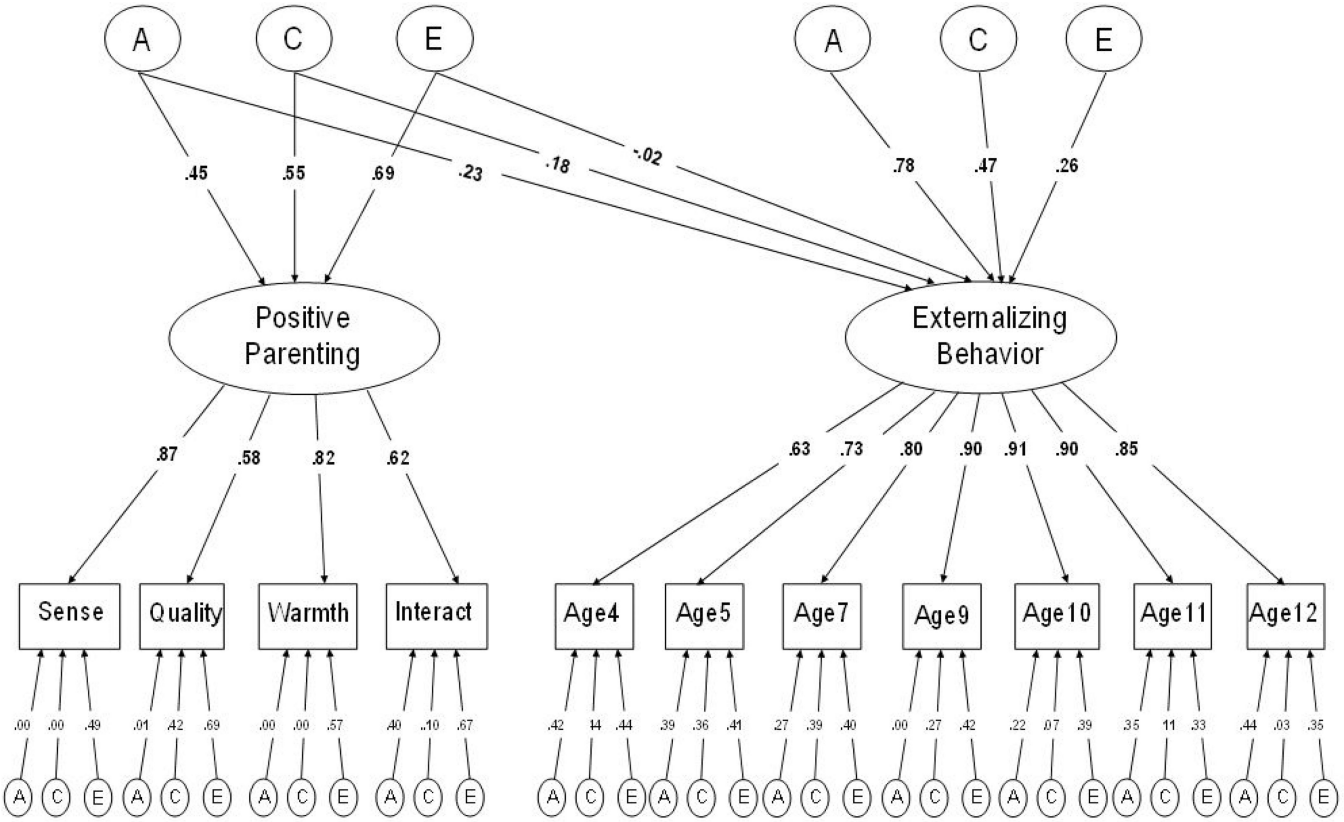

Figure 2.

Results of the full bivariate common pathway model with separate factors for Positive Parenting and Externalizing Behavior for the entire sample. sense = maternal sensitivity; quality = maternal quality of instruction; warmth = maternal warmth; interact= overall rating of mother–child interaction; A=magnitude of genetic influences; C= magnitude of shared environmental influences; E= nonshared environmental influences on positive parenting, externalizing behavior, and the covariance between positive parenting and externalizing behavior.

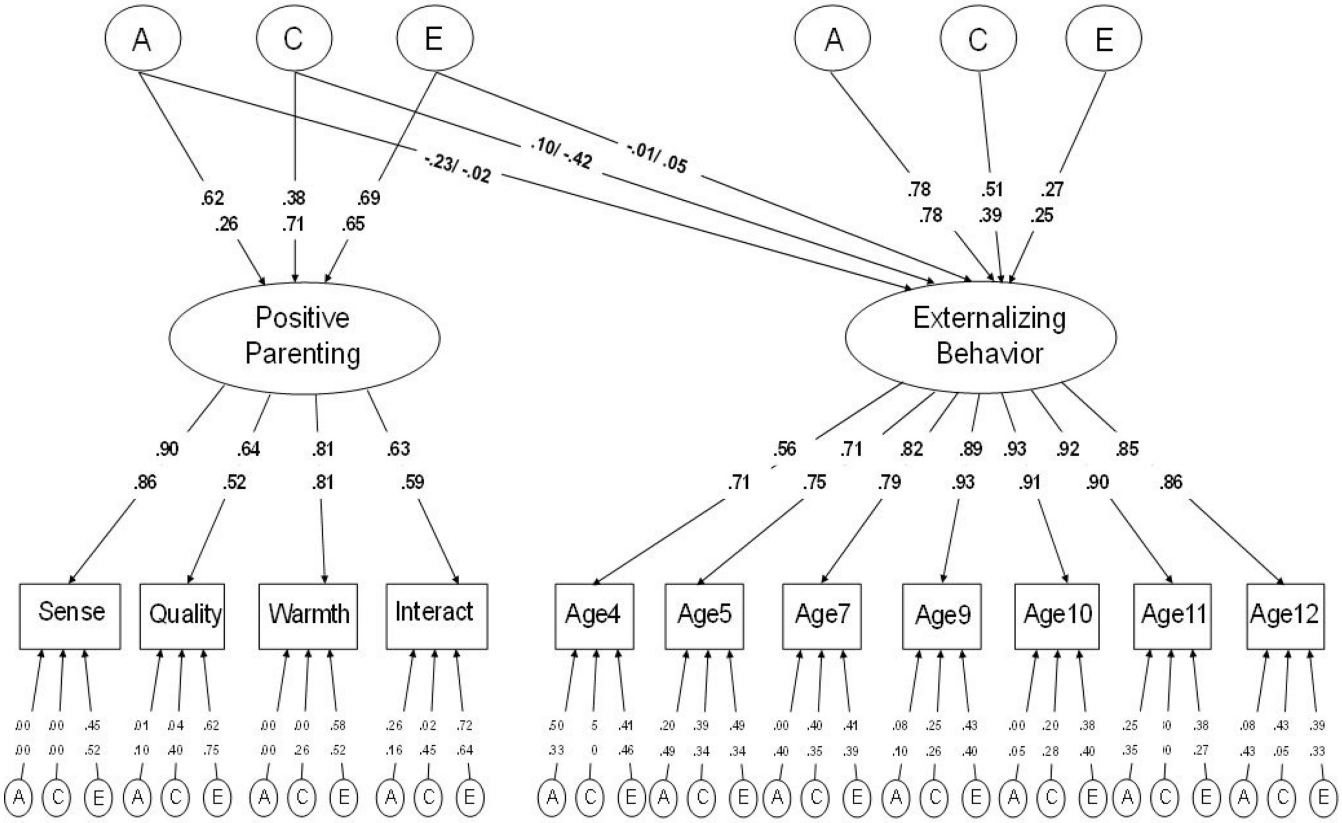

Figure 3.

Results of the full bivariate common pathway model with separate factors for Positive Parenting and Externalizing Behavior for boys and girls. sense = maternal sensitivity; quality = maternal quality of instruction; warmth = maternal warmth; interact= overall rating of mother–child interaction; A=magnitude of genetic influences; C= magnitude of shared environmental influences; E= nonshared environmental influences on positive parenting, externalizing behavior, and the covariance between positive parenting and externalizing behavior. Top/left number indicates boys and bottom/right number indicates girls.

Table 1

Sample Sizes

Positive Parenting					Externalizing Behavior						
7 months	**9 months**	**14 months**	**24 months**	**36 months**	**4 years**	**5 years**	**7 years**	**9 years**	**10 years**	**11 years**	**12 years**
308	286	374	334	277	581	491	597	544	470	440	547

Note. Number of parenting observations completed at each time point in toddlerhood and number of individuals with externalizing measurements at each time point.

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Table 2

Phenotypic Correlations Among Individual Parenting Variables at Each Age for the Full Sample and Separately by Gender

		7 Months	9 months	14 months	24 months	36 months
Sensitivity	7 months	1	.11**/.08/.15*	−.01/.04/−.06	.03/.01/.05	.02/.07/−.03
	9 months		1	.01/.05/−.05	.01/−.06/.10	−.06/−.05/−.09
	14 months			1	.12*/.16+/.08	.16**/.06/.27**
	24 months				1	.07/.10/−.01
	35 months					1
Warmth	7 months	1	.25**/.26**/.24**	−.02/.01/−.04	.03/.05/−.01	.02/.06/.02
	9 months		1	.05/.06/.06	.02/.03/−.01	−.07/−.01/−.15
	14 months			1	.21**/.15*/.28**	.15*/.16*/.10
	24 months				1	.08/.17*/−.08
	35 months					1
Quality of Instruction	7 months	1	.33**/.28**/.42**	.06/.12/.01	.16*/.10/.29**	.05/.06/.09
	9 months		1	.03/−.01/.11	.20**/.20*/.18	.01/−.07/.17
	14 months			1	.18**/.18*/.17+	.11/.01/.22+
	24 months				1	.33**/.24**/.46**
	35 months					1
Overall Interaction	7 months	1	.19*/.30**/.50	−.03/.00/−.05	.04/.11/−.06	−.01/.08/−.12
	9 months		1	.10/.02/.18	.03/−.03/.14	.03/.07/−.01
	14 months			1	.06/−.08/.20	.03/−.11/.16
	24 months				1	.16*/.07/.25+
	35 months					1

Note. Results for the full sample are presented by the first number, results for females are presented by the second number, and results for males are presented by the third number

+ p < .10,

** p<.01,

* p<.05.

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Table 3

Phenotypic Correlations Among Parenting Variables Averaged Across Age

		Sensitivity	Quality of Instruction	Warmth	Overall Interaction
All	Sensitivity	1	.56**	.72**	.51**
	Quality of Instruction		1	.41**	.38**
	Warmth			1	.53**
	Overall Interaction				1
Girls	Sensitivity	1	.50**	.70**	.48**
	Quality of Instruction		1	.34**	.32**
	Warmth			1	.52**
	Overall Interaction				1
Boys	Sensitivity	1	.60**	.73**	.52**
	Quality of Instruction		1	.47**	.44**
	Warmth			1	.54**
	Overall Interaction				1

Phenotypic Correlations Among Externalizing Variable

All		Age 4	Age 5	Age 7	Age 9	Age 10	Age 11	Age 12
	Age 4	1	.73**	.66**	.56**	.58**	.55**	.44**
	Age 5		1	.70**	.63**	.63**	.59**	.54**
	Age 7			1	.67**	.67**	.62**	.63**
	Age 9				1	.80**	.77**	.72**
	Age 10					1	.80**	.75**
	Age 11						1	.79**
	Age 12							1
Girls	Age 4	1	.78**	.66**	.58**	.61**	.62**	.49**
	Age 5		1	.70**	.63**	.61**	.63**	.53**

Phenotypic Correlations Among Externalizing Variable								
All		**Age 4**	**Age 5**	**Age 7**	**Age 9**	**Age 10**	**Age 11**	**Age 12**
	Age 7			1	.60**	.61**	.62**	.63**
	Age 9				1	.80**	.81**	.75**
	Age 10					1	.78**	.75**
	Age 11						1	.81**
	Age 12							1
Boys	Age 4	1	.68**	.64**	.53**	.53**	.43**	.36**
	Age 5		1	.70**	.63**	.65**	.54**	.55**
	Age 7			1	.74**	.74**	.59**	.61**
	Age 9				1	.79**	.72**	.69**
	Age 10					1	.80**	.74**
	Age 11						1	.76**
	Age 12							1

Note.

** p<.01.

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Table 4

Phenotypic Correlations between Latent Parenting and Externalizing Behavior Factors at Each Age

	Age 4	Age 5	Age 7	Age 9	Age 10	Age 11	Age 12
All	−.18*	−.15*	−.13*	−.11	−.16*	−.24**	−.12
Girls	−0.28*	−.14	−.22**	−.16	−.19	−.26*	−.16
Boys	−0.05	−.13	.01	−.03	−.04	−.07	−.05

Note.

+ p < .10,

** p<.01,

* p<.05.

Table 5

Phenotypic, Within-trait Cross-twin, and Cross-trait Cross-twin Correlations

		Phenotypic Correlation	MZ	DZ
Mean Parenting	All		.57**	.58**
	Girls		.59**	.74**
	Boys		.52**	.49**
Mean Externalizing	All		.89**	.60**
	Girls		.88**	.60**
	Boys		.88**	.57**
Mean Parenting-Mean Externalizing	All	−.15**	−.20**	−.12
	Girls	−.18**	−.18	−.19
	Boys	−.09	−.19	−.03

Note. Within-trait cross-twin correlations and cross-trait cross-twin correlations.

** p <.01.

Table 6

Variance of Externalizing Behavior and Covariance Between Positive Parenting and Externalizing Behavior Explained by a^2, c^2, and e^2

Variance of Externalizing Behavior Shared in Common with Positive Parenting				Variance Specific to Externalizing Behavior				Covariance (% of covariance) between Positive Parenting and Externalizing Behavior			
	a^2	**c^2**	**e^2**		**a^2**	**c^2**	**e^2**		**a^2**	**c^2**	**e^2**
All	.05	.03	.00	All	.61	.22	.07	All	−.13 (59%)	−.07 (32%)	.02 (9%)
Boys	.05	.01	.00	Boys	.60	.26	.08	Boys	−.14 (74%)	.04 (21%)	−.01 (5%)
Girls	.00	.17	.00	Girls	.61	.16	.06	Girls	.00 (0%)	−.30 (91%)	.03 (9%)

Table 7

Model Fitting Results for Bivariate Common Pathway Models

	Dropped Pathway	−2LL	df	AIC	$\Delta\chi^2$	Δdf	p
Same Parameters for Boys and Girls	Full Model	11714.744	5279	1156.744			
	Common Genetic Pathway	11716.830	5280	1156.830	2.09	1	0.15
	Common Shared Environment Pathway	11715.762	5280	1155.762	0.64	1	0.42
	Common Nonshared Environment Pathway	11716.822	5280	1156.822	2.08	1	0.15
	All Common Pathways	11722.990	5282	1158.099	8.24	3	0.04
Separate Parameters	Full Model	11660.886	5228	1204.886			
Boys	Common Genetic Pathway	11662.497	5229	1204.497	1.61	1	0.204
	Common Shared Environment Pathway	11661.563	5229	1203.563	0.68	1	0.411
	Common Nonshared Environment Pathway	11661.291	5229	1203.291	0.41	1	0.525
	All Common Pathways	11663.235	5231	1203.291	2.35	3	0.125
Girls	Common Genetic Pathway	11661.046	5229	1203.046	0.16	1	0.689
	Common Shared Environment Pathway	11665.651	5229	1207.651	4.77	1	0.029
	Common Nonshared Environment Pathway	11662.101	5229	1204.101	1.22	1	0.270

Note. Models conducted to examine the statistical significance of common genetic, shared environmental, and nonshared environmental influences between positive parenting and child externalizing in boys and girls.