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Correlates of Positive Parenting Behaviors

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Abstract

The present study examined the influence of maternal and child characteristics on parenting behaviors in a genetically informative study. The participants were 976 twins and their mothers from the Colorado Longitudinal Twin Study and the Twin Infant Project. Indicators of positive parenting were coded during parent–child interactions when twins were 7–36 months old. Child cognitive abilities and affection were independent correlates of positive parenting. There were significant gender differences in the magnitude of genetic and environmental influences on positive parenting, with shared environmental influences on parenting of girls and additive genetic influences on parenting of boys. Girls received significantly more positive parenting than boys. Differences in etiology of positive parenting may be explained by developmental gender differences in child cognitive abilities and affection, such that girls may have more rewarding interactions with parents, evoking more positive parenting.

Keywords

Parenting; Twin study; Gene–environment correlation

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Compliance with Ethical Standards

Conflict of Interest Kerri E. Woodward, Debra L. Boeldt, Robin P. Corley, Lisabeth DiLalla, Naomi P. Friedman, John K. Hewitt, Paula Y. Mullineaux, JoAnn Robinson, and Soo Hyun Rhee declare that they have no conflicts of interest.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Human and Animal Rights This article does not contain any studies with animals performed by any of the authors.

Informed Consent Informed consent was obtained from all individual participants included in the study.

Introduction

Positive and responsive parenting is related to significantly fewer externalizing behaviors and improved impulse control in childhood (Amato and Fowler 2002; Boeldt et al. 2012; Moffitt 2003; Olson et al. 1990). Early experiences of parental support are related to higher school grades, fewer conduct problems, less substance use, greater mental health, better social skills, and better self-image in children from preschool through college age (Amato and Fowler 2002). Multiple measures of parental behaviors and quality of the mother–child relationship (e.g. maternal sensitivity, support, etc.) evaluated in children age 6–42 months have been found to be significantly correlated with the child’s high school graduation status by age 19 years; these parental characteristics were more powerful predictors of high school completion than either child IQ or academic achievement (Jimerson et al. 2000). Also, a study that examined a subset of the current sample found that observed positive parenting during toddlerhood was significantly and negatively associated with parent ratings of child externalizing behaviors assessed between 4 and 12 years of age (Boeldt et al. 2012). However, the transactional nature of the parent and child behaviors as they affect positive parenting has not been well delineated, especially with respect to genetic effects on these behaviors. The present study aimed to address this gap in the literature by examining the role of maternal and child characteristics that are independent correlates of positive parenting in a genetically-informative design.

Despite consistent support for the role of positive parenting in child development outcomes, few studies have examined multiple possible maternal and child characteristics as independent correlates of positive parenting simultaneously. Also, clarification of the mechanisms underlying parenting behaviors may inform parenting-based therapies for child behaviors. A common assumption is that the quality of parent–child interactions shapes the child’s developing framework for acceptable behaviors and values, differentially encouraging prosocial or antisocial behaviors (Biglan et al. 2012; Patterson et al. 1989). Further, maternal characteristics may influence parenting behaviors and nurturance, which in turn influence child outcome. Researchers have observed that mothers’ temperament, age, education, mental health, and marital quality are all significantly correlated with ratings of maternal warmth (Kendler et al. 1997; Russell 1997). Further, maternal personality and psychopathology (e.g. maternal neuroticism, conscientiousness, depressive symptoms, and history of affective or anxiety disorders) are strong correlates of parental warmth (Kendler et al. 1997; Prinzie et al. 2009).

However, it is important to consider that children influence parenting behaviors as well (through evocative rGE, see below and Deater-Deckard and O’Connor 2000; Klahr and Burt 2014; Neiderhiser et al. 2004). Studies have found that specific child characteristics such as language and cognitive abilities, temperament, and behavior problems were correlated with parenting behaviors (Fulgini et al. 2004; Kendler et al. 1997; Verhoeven et al. 2007). For example, children with temperamental reactivity and negative emotion tend to experience less parental warmth than children with less negative emotionality (Kendler et al. 1997). Similarly, children with more positive affect tend to engage in more responsive and warmer parent–child interactions (Deater-Deckard and O’Connor 2000; Russell 1997). Further,

children who have more advanced language and cognitive abilities tend to receive greater levels of parental warmth (Fuligni et al. 2004), a pattern that could arise if interactions with more developmentally advanced children are more rewarding to parents. However, it is also possible that more positive interactions with parents may lead to better language development in children.

There is also remaining uncertainty regarding the etiology of positive parenting. Although a unidirectional model suggesting that a particular environment has a causal effect on behavior is commonly discussed in the literature, there are also genetic influences on putatively environmental factors, such as parenting behaviors and family characteristics. A review by Kendler and Baker (2007) concluded that these environmental variables, including positive parenting, are significantly heritable, suggesting that an individual's genetically influenced characteristics may shape their environment. The etiology of positive parenting behaviors can be better understood using genetically informed study designs.

Twin studies take advantage of the difference in genetic relatedness of monozygotic (MZ) versus dizygotic (DZ) twin pairs and have typically addressed questions of additive influences of genes on development. Because MZ twins share all of their genes, whereas DZ twins share, on average, half of their segregating genes, heritable influences (a^2 ; i.e., additive genetic) are inferred when MZ twins are significantly more similar on a characteristic than DZ twins. If DZ twins are also very similar on a certain characteristic, it is likely that there are shared environmental influences (c^2 ; i.e., environmental influences leading to similarities between sibling pairs) on a trait. Differences between MZ twin pairs are due to nonshared environmental influences (e^2 ; i.e., environmental influences leading to differences between sibling pairs), which can include measurement error.

Twin studies can also support the investigation of non-additive genetic influences, such as gene–environment correlations (rGE), which may exist when genetically influenced characteristics are correlated with a child's environmental experience. rGE can be either passive—when the environment is influenced by parents' characteristics—or evocative—when child characteristics evoke environmental conditions. Significant c^2 may be consistent with the influence of the shared environment: For instance, shared environmental influences could include such variables as family structure, available community resources, and general socioeconomic status that all children in a family experience, which may or may not be related to parents' characteristics. Significant c^2 may also be consistent with passive rGE, which is an association between parents' genetically influenced characteristics and parenting behaviors (Neiderhiser et al. 2004; Plomin et al. 1977, 2000). Passive rGE would be implicated if parenting behaviors were correlated with parent characteristics that are putatively genetic, such as neuroticism, and if parents treat their children similarly regardless of the children's genetic relatedness (i.e., twins would be treated similarly whether they are MZ or DZ). In contrast, a significant effect of children's genes on parenting is consistent with evocative rGE, or a child's genetically influenced characteristics evoking a particular parental response (Neiderhiser et al. 2004; Plomin et al. 2000). When there is evocative rGE, children who are more similar genetically would be treated more similarly than children who are less similar genetically (i.e., in a twin study, MZ twins would be treated more similarly than DZ twins). A recent review suggested that children (age 5 months through adulthood)

are not passive recipients of parenting behaviors; rather, children's genetic characteristics seem to influence the parenting they receive, which is consistent with evocative rGE (Klahr & Burt, 2014).

Child gender is a characteristic that has been shown to be associated with parent-child interactions, such that girls receive more positive parenting from their mothers than boys (e.g., Boeldt et al. 2012), and boys are more likely to receive harsh or corporal punishment from both mothers and fathers (Mahoney et al. 2000; McKee et al. 2007). Mahoney and colleagues (2000) noted that the gender difference in harsh parenting behaviors was mostly explained by differences in child externalizing behaviors. Therefore, the associations between parent characteristics, child characteristics, and parenting behaviors may differ between male and female children; however, the literature is generally lacking studies that investigate gender differences in the etiology of parenting behaviors. Although there may be an interaction between parent and child gender in parent-child interaction quality (e.g., Keenan and Shaw 1997), the present study is focused on differences in child gender, as only mother-child interaction data were available.

The present study

The present study aimed to investigate correlates of and mechanisms underlying positive parenting behaviors in a genetically informative sample. We examined potential maternal and child correlates of parenting behaviors that were suggested by the literature. Given our review of previous studies, we predicted that: (1) Higher maternal educational attainment, age, IQ, socioeconomic status, and marital satisfaction would be related to more positive parenting behaviors, whereas higher maternal neuroticism would be correlated with fewer positive parenting behaviors; (2) Greater child language abilities, cognitive abilities, and observed affection would be associated with more positive parenting behaviors, whereas child negative emotionality would be negatively associated with positive parenting behaviors.

We also examined whether any of the significant correlates have an independent influence on positive parenting behaviors. We examined whether there are significant genetic, shared environmental, and nonshared environmental influences on positive parenting behaviors, which can suggest whether results are consistent with passive or evocative rGE on positive parenting. Finally, we investigated gender differences in all analyses given evidence of significant differences in the parenting of boys and girls in the literature.

Method

Participants

The present study includes 976 twins from same-gender twin pairs born between 1984 and 1990 from 488 families. Participants were recruited through the Colorado Department of Health as part of either the Twin Infant Project (TIP; DiLalla et al. 1990) or the Longitudinal Twin Study (LTS; Emde and Hewitt 2001; Rhea et al. 2013). The full sample includes 138 female MZ twin pairs, 106 female DZ twin pairs, 126 male MZ twin pairs, 115 male DZ twin pairs, and 1 female and 2 male twin pairs with unknown zygosity who were only

included in phenotypic analyses. Given that this is a longitudinal study, not all measures are available for all participants. Appendix Table 5 shows the sample size of all variables at each time point, and the effective sample size for each analysis is included in the results section. The number of twin pairs with parenting interaction data is lower, ranging from 114 to 260 families. Approximately 86% of the twin pairs were non-Hispanic Caucasian. Mothers were on average 29.65 years old (*range* = 19 to 43; *SD* = 4.51) at the twins' birth and had an average of 14.44 years of education (*range* = 9 to 21; *SD* = 2.06).

Zygosity determination

Zygosity of the twin pairs was determined phenotypically through a 10-item questionnaire completed by multiple raters. To be considered accurate, zygosity determination in the LTS sample required an 85% rater agreement between 4 individual raters. In the TIP sample, zygosity determination was considered accurate when 2 individual raters reached complete agreement. Phenotypic zygosity ratings were confirmed with 9 or more polymorphic simple tandem repeat markers between the twins in 92% of the sample.

Measures

Positive parenting—Data for the present study were collected during home visits when twins were 7, 9, 14, 20, 24, and 36 months old. When the twins were 7 and 9 months of age, mothers were recorded eliciting vocalizations from their children. At 14, 20, 24, and 36 months, mothers were recorded teaching their twins a sorting task. The interactions were triadic between both twins and their mother at all time points; at 36 months, dyadic interactions were also recorded. Recorded mother–child interactions ranged from 2.5 to 7 min long. Observed parent and child behaviors were later coded for the first 2.5 min of each interaction using both microanalytic behavioral ratings and a global coding scheme (DiLalla and Bishop 1996; Mullineaux and DiLalla 2007). The present study used results from the global coding scheme, which had good inter-observer reliability between raters ($r_s = 0.74$ to 0.90). Behaviors were coded using a Likert scale, and a further description of these items can be found in Table 1.

A latent construct of positive parenting was developed for the purpose of this study. The global coding scheme variables that were significantly correlated with each other at all time points (maternal sensitivity, reverse coded maternal warmth, and maternal quality of instruction on a teaching task) were chosen. Given missing data across time points, and to reduce error, each variable was averaged across time points. We calculated the average age at which each twin had data and regressed it out of the average sensitivity, warmth, and quality of instruction variables, given that positive parenting increased somewhat as age increased.¹ The latent positive parenting factor had statistically significant loadings from maternal sensitivity (0.88 for males; 1.00 for females), warmth (0.63 for males; 0.54 for females), and quality of instructions (0.63 for males; 0.57 for females).

¹Given missing data, the ages at which participants had available data varied. Therefore, the most accurate way to calculate an age-independent value of positive parenting received is to regress out the average age of data collection from parenting variables.

Parental characteristics—Maternal IQ was assessed when twins were 1 year old in the TIP sample and 7 years old in the LTS sample using the Wechsler Adult Intelligence Scale (WAIS; Wechsler 1955) Vocabulary subtest. Maternal education was assessed in a demographics questionnaire completed by the parents when the twins were 14 months old. Maternal neuroticism was assessed using the Eysenck Personality Inventory (EPI; Eysenck and Eysenck 1975) when the twins were 14 and 36 months old and scores from these two time points were combined into an average maternal neuroticism score. The National Opinion Research Center (NORC; Davis et al. 1991) Occupational Code, which rates jobs based on prestige and relative to other jobs, was used as an estimate of socioeconomic status. Both mother and father NORC scores were examined. Finally, data on parental relationship satisfaction were assessed using the Spanier Dyadic Adjustment Scale (DAS; Spanier 1976) from both mothers and fathers when twins were 14 and 36 months old.

Child characteristics—Child affection was an observed measure collected during the mother–child interactions at 7, 9, 14, 20, 24, and 36 months. Two global coding scheme variables, child affection and enthusiasm, were significantly correlated at each time point, and examples of each measure are shown in Table 1. Because of missing data and to reduce error, each variable was averaged across time points, and the average age of data collection was regressed out. A latent child affection factor had significant loadings on child affection (0.91 for males; 0.97 for females), and child enthusiasm (0.75 for males; 0.74 for females).

Child cognitive abilities were measured using the Mental Development Index (MDI) of the Bayley Scales of Mental Development (Bayley 1969) at 14, 20, and 24 months, and the Stanford–Binet Form L–M intelligence quotient score (Terman et al. 1973) at 36 months. A latent variable with loadings on child cognitive ability from each of the four time points was examined. The Bayley Scales of Mental Development contain 90 items that evaluate problem solving skills, fine motor coordination, and vocabulary in early childhood, and the MDI was used in this study. The Stanford–Binet Intelligence Test similarly evaluates general cognitive abilities, and the overall IQ score was used in this study. A latent factor of child general cognitive abilities was calculated with loadings on both the Bayley MDI and Stanford–Binet IQ at each time point, respectively.

Child expressive and receptive linguistic abilities were evaluated using the Sequenced Inventory of Communication Development (SICD; Hedrick et al. 1975) at 14, 20, 24, and 36 months and were evaluated using latent variables of expressive and receptive language abilities with loadings on language abilities assessed at each time point. The SICD was adapted in this study to measure child expressive and receptive language using a subset of age-appropriate items at each time point. To measure expressive language abilities, children were asked questions requiring the production of sounds or words (e.g. “What says ‘Meow?’”). In contrast, measures of receptive language abilities evaluated the child’s understanding of words or phrases (e.g. “Give me the shoe and the dog.”). Expressive and receptive language abilities were evaluated separately.

A measure of child negative emotionality was obtained using three observational measures including Restraint, Toy Removal, and observations during the Bayley Scales of Infant Development (Bayley 1969) at 14, 20, and 24 months. The restraint task lasted up to 3 min,

during which the child was instructed to lie still and was restrained while the examiner measured the child's height. In the toy removal task, a toy that the child had been playing with for 2 min was removed abruptly. For both tasks, a frustration coding scheme that scored levels of child expressivity, protest, and distress was used, and these measures were used to create a single factor score. Inter-rater reliability for this coding scheme was 0.69 for expressivity, 0.75 for protest, and 0.89 for distress. Negative hedonic tone was measured by recording the child's strongest negative affect at 1-min intervals within alternating 5-min segments of the Bayley Scales using the Negative Hedonic Tone Coding scheme (Easterbrooks and Emde 1983), with an inter-rater reliability of 0.84. The average negative affect across all intervals was examined. The scores were all converted to proportions of the highest score to create an equal scale across measures. An overall negative emotionality score was created by averaging the calculated proportions for restraint, toy removal, and negative hedonic tone at each time point, then a latent factor with loadings on the overall negative emotionality score at each time point was examined.

Data analyses

Data analyses were conducted using Mplus 7 (Muthén and Muthén, 1998–2014), using the maximum likelihood with robust standard errors (MLR) estimation method, which provides standard errors and Chi square test statistics that are robust to non-normality. When using MLR, Mplus analyzes missing data using the missing at random technique, by which missing data are considered a function of observed covariates and outcomes (Little and Rubin 2002). In the phenotypic analyses, the Type = COMPLEX option was used, which allowed data from twins to be nested within twin pairs. This also addressed non-independence in the computation of standard errors and model fit.

Chi square tests were used to evaluate model fit; however, due to the Chi square test's sensitivity to sample size, the Tucker-Lewis Index (TLI; Tucker and Lewis 1973; Bentler 1990), comparative fit index (CFI; Bentler 1990), and root-mean-square error of approximation (RMSEA; Browne and Cudeck 1987; Steiger and Lind 1980) were also evaluated. Good model fit is indicated by a TLI greater than 0.95, a CFI greater than 0.95, and an RMSEA less than 0.06 (Hu and Bentler 1998). Means and standard deviations of all variables are shown in Appendix Table 6, which presents both the results for the whole sample and separate results for boys and girls. Mean gender differences in all variables were examined using *t*-tests in SPSS 23 (IBM Corp 2015; see Appendix Table 6). Subsequent analyses allowed gender differences at the mean intercept level of variables. Given observed gender differences, the final models had gender-specific indicator intercepts and factor loadings. The latent factor means were fixed to 0 given the free intercepts, and the latent factor variances were fixed to 1, given that all factor loadings were free.

Correlations and multiple regression analyses—We calculated correlations between the hypothesized correlates and positive parenting behaviors. Child gender differences in these correlations were investigated by testing the Chi square difference between the model in which the correlations were allowed to vary across gender versus the model in which they were constrained to be equal; all correlations could be equated between males and females without significant detriment to model fit. Variables that correlated significantly with

positive parenting were examined further in multiple regression analyses to investigate possible independent effects of maternal and child characteristics on parenting behaviors.

Univariate and bivariate genetic models—A univariate genetic model evaluating the relative parenting similarity between MZ versus DZ twin pairs was conducted. The magnitudes of genetic, shared environmental, and non-shared environmental influences on parenting behaviors were estimated, and statistical significance of the parameters was determined by *p*-values for z-tests based on ratios of parameters/standard errors. Bivariate models were tested to examine whether there are common genetic and environmental influences on child characteristics (i.e., child affection and child cognitive abilities) and positive parenting. As in our correlation analyses, all models were evaluated separately by gender, then compared using chi-squared difference tests to a model with parameters equated between genders to evaluate whether the parameters were significantly different between males and females.

Results

Correlations and multiple regression analyses

Table 2 presents the correlations between the hypothesized correlates and positive parenting. Generally, fixing the correlations between boys and girls did not have a significantly negative impact on model fit, which suggests that the correlations for males and females are not significantly different. Therefore, we present results from models in which correlations were fixed across genders, although intercepts and factor loadings were still allowed to vary. Maternal education, maternal and paternal marital satisfaction, child general cognitive ability, child expressive language abilities, child receptive language abilities, and child affection were all significantly correlated with positive parenting behaviors. There was a trend of a negative correlation between the average maternal neuroticism score and positive parenting.

Many of the maternal and child characteristics that correlated with positive parenting were significantly associated with each other (see Appendix Table 7). Therefore, the significant correlates of positive parenting were included in multiple regression analyses to investigate whether any variables were independent correlates of positive parenting. Child expressive and receptive language abilities were excluded from multiple regression analyses, given the very high correlation between child general cognitive ability and child language abilities (see Appendix Table 7). Only child general cognitive ability and child affection were significant independent correlates of positive parenting (Table 3). Because child affection and positive parenting were coded from the same mother–child interactions, a multiple regression analysis was completed with all variables except child affection, and the same pattern of results emerged, with only child general cognitive ability being a significant independent correlate of positive parenting behaviors ($r = 0.22$, $p = 0.01$, $n = 824$).

Univariate behavior genetic model

Twin correlations were calculated for parenting behaviors. If the MZ twin correlations are larger than the DZ twin correlations, additive genetic effects may be influencing parenting

behaviors; if the MZ twin correlations are less than twice the DZ twin correlations, shared environmental effects may also be influencing parenting behaviors. Overall, there was more consistent evidence for genetic influences on positive parenting behaviors in male than in female children (Table 4). In males, the MZ correlations were larger than the DZ correlations, suggesting there may be genetic influences on parenting behaviors. In females, however, MZ and DZ correlations were similar, suggesting shared environmental influences on positive parenting. A univariate genetic analysis suggested significant gender differences in the relative magnitude of genetic and environmental influences on positive parenting, as the model allowing parameters to be free across gender fit significantly better than the model fixing them to be equal across gender, $\chi^2(3) = 27.52, p < 0.001$. In boys, there were significant additive genetic influences on positive parenting (Fig. 1), suggesting that boys' genetically-influenced characteristics may be influencing parenting behaviors (i.e., evocative rGE); in girls, there were significant shared environmental influences (Fig. 1), which may indicate either passive rGE or shared environmental influences, including those that are a result of the parents' characteristics.

Bivariate behavior genetic models

Cross-twin cross-trait correlations were calculated to determine the expected pattern of genetic and shared environmental influences in bivariate genetic analyses; these correlations allow one variable in one twin to correlate with a different variable in the other twin. Greater MZ than DZ cross-trait cross-twin correlations indicate common genetic influences, and MZ cross-trait cross-twin correlations less than twice the DZ correlations indicate common shared environmental influences between parenting behaviors and child characteristics. The results suggest that in males, parenting behaviors and child affection may have common genetic influences, whereas parenting behaviors and child general cognitive ability may have common shared environmental influences (Table 4). In females, common shared environmental influences were implicated in both the association between parenting behaviors and child affection and the association between parenting behaviors and child general cognitive ability (Table 4).

The covariance between child characteristics (child affection and child general cognitive ability) and positive parenting was examined in bivariate genetic analyses. In both analyses, we were unable to test whether there was significant detriment to model fit when the loadings between boys and girls were equated, because the models would not converge when all parameters were equated across genders. In both models, shared environmental effects on parenting were fixed to 0 in boys and genetic effects on parenting were fixed to 0 in girls for model convergence. Of note, this requirement results in a model with constrained standard errors, which may result in artificially inflated estimates of significance. In boys, there were significant additive genetic influences on positive parenting that were shared with those for child affection, and unique genetic effects on positive parenting were not significant (see Fig. 2). In girls, there were significant shared environmental influences on positive parenting that were shared with those for child affection, and unique shared environmental influences on positive parenting remained significant (see Fig. 2). Analyses examining child general cognitive ability and positive parenting behaviors indicate significant shared environmental influences on positive parenting that were shared with those for child general cognitive

ability in girls. In boys, neither the genetic nor shared environmental influences on positive parenting that were shared with those for child general cognitive ability were significant (see Fig. 3). These results are generally consistent with the findings from the cross-twin cross-trait correlation analysis.

Examination of gender

Gender was significantly associated with all positive parenting variables, with girls receiving significantly more positive parenting than boys (see **). However, when gender was included in the multiple regression analysis including all other significant correlates (maternal neuroticism, maternal education, child general cognitive ability, and child affection), child gender was no longer a significant correlate of positive parenting ($\beta = -0.02$, $p = 0.64$, $n = 708$), whereas child general cognitive abilities and child affection remained significant. Gender was also not a significant correlate of positive parenting after controlling only for the two significant independent correlates of positive parenting, child affection and child general cognitive ability ($\beta = -0.02$, $p = 0.58$, $n = 824$). When controlling only for child affection, gender was still not a significant independent correlate of positive parenting behaviors ($\beta = -0.05$, $p = 0.22$, $n = 611$). However, gender was a significant independent correlate of parenting behaviors ($\beta = -0.11$, $p = 0.03$, $n = 824$) in the multiple regression analysis controlling for child general cognitive ability. Mediation analyses suggested that both child general cognitive ability (indirect effect via general cognitive ability $\beta = -0.09$, $p = 0.006$; direct effect of gender $\beta = -0.18$, $p = 0.05$, $n = 824$) and child affection (indirect effect via affection $\beta = -0.19$, $p = 0.001$; direct effect of gender $\beta = -0.07$, $p = 0.36$, $n = 611$) were statistically significant mediators of the association between gender and positive parenting; however, due to limited sample size, we could not address the direction of effect between general cognitive ability/child affection and positive parenting using longitudinal data.

Model modifications

Models met the criteria for good fit with a few exceptions. In the model examining the association between child expressive language and positive parenting, expressive language ability assessed closer in time correlated more highly than that assessed further apart in time, and adding residual correlations between adjacent time points resulted in good model fit. Also, in the model examining the association between maternal education and positive parenting, maternal education had a higher correlation with maternal warmth than the other two indicators of positive parenting, and adding an additional correlation between maternal education and maternal warmth resulted in the model meeting the criteria for good fit. There was also one instance within the multiple regression analysis of a TLI = 0.93, which is less than the TLI > 0.95 cutoff; however, all other fit indices met the criteria for good fit. Similarly, the model estimating the phenotypic and twin correlations between child general cognitive ability and positive parenting had a CFI = 0.94 below the CFI > 0.95 cutoff, although all other estimates meet criteria for good fit. The model estimating the phenotypic and twin correlations between child affection and positive parenting did not meet criteria for good model fit with TLI = 0.93 and RMSEA = 0.07, both outside the guidelines for good model fit. Similarly, the bivariate Cholesky model examining the association between child affection and positive parenting had a TLI = 0.92 and RMSEA = 0.08. Lack of good fit in

these models may be due to the model assumptions that means, variances, and phenotypic correlations between the variables are fixed to be equal between twin 1 and twin 2 and between MZs and DZs, when there may be inequality between twins 1 and 2 due to randomization. Consistent with this hypothesis, there was a significant difference in the fit of a model that allowed the phenotypic correlations to be free versus a model that fixed correlations to be equal between twins 1 and 2 and MZs and DZs ($\chi^2(60) = 79.85, p = 0.04$).

Discussion

The present study investigated correlates of positive parenting in a genetically informative sample. Of the parental characteristics, maternal neuroticism, maternal education, and maternal and paternal marital satisfaction were significantly correlated with positive parenting behaviors. Of the child characteristics, child general cognitive ability, expressive and receptive language abilities, and affection were significantly correlated with positive parenting. This study goes beyond previous studies by evaluating multiple literature-suggested correlates of positive parenting to examine which are independent correlates of positive parenting behaviors. In the multiple regression analysis, only child general cognitive abilities and affection were found to be significant independent correlates of positive parenting behavior and were thus the only correlates included in genetic analyses.

Girls received significantly more positive parenting behaviors than boys. However, child gender was no longer significantly related to positive parenting behaviors when included in a multiple regression analysis with other significant independent child correlates of positive parenting. Child general cognitive ability was a significant partial mediator of the gender difference in positive parenting. These results suggest that some of the gender difference in positive parenting behaviors may be explained by the developmentally expected gender differences in cognitive and linguistic abilities in early development, as suggested by previous studies and literature reviews (Andersson and Sommerfelt 2001; Keenan and Shaw 1997). When only child affection and child gender were included in a multiple regression analysis, child gender was no longer significantly related to positive parenting behaviors, and child affection completely explained the gender difference in positive parenting. Although this result may be an artifact of child affection and parenting variables being coded during the same interaction, it also underscores the transactional relationship between parents and children, such that child affection can encourage increased positive parenting and vice versa within an interaction and across time points. Further, it is possible that the observed gender differences in positive parenting are a result of biologically innate gender differences in an early childhood propensity to show affection or due to differential socialization of boys and girls that encourages more affection displays from girls, which leads to more positive parenting (Keenan and Shaw 1997; Robinson et al. 1993).

The child characteristics found to be correlated with positive parenting require further analyses, as direction of effect is unclear. Children who have greater cognitive abilities and who are more affectionate may be more rewarding to parents and thus may evoke more positive parenting behaviors (i.e., evocative gene–environment correlation). However, passive gene–environment correlation is another possibility. Specifically, parents who are genetically predisposed to have strong cognitive abilities may shape their child's

environment and their interactions to develop the child's cognitive abilities. Similarly, parents who tend to be more affectionate themselves may show more affection toward their child in parent-child interactions, resulting in a child who is more affectionate due to both genetic predispositions and rearing environment.

The magnitude of the correlations between the specific measured correlates and parenting behaviors was not significantly different between boys and girls, but there were significant gender differences in the relative magnitude of genetic and environmental influences on parenting behaviors. In univariate genetic analyses, positive parenting was significantly influenced by genetic and nonshared environmental influences in boys, and significantly influenced by shared and nonshared environmental influences in girls. These results are consistent with evocative rGE in parenting of boys, such that positive parenting received by boys is due to the children's genetically influenced characteristics. In contrast, positive parenting received by girls is explained more by their mother's genetically influenced characteristics (i.e., passive rGE) or by the shared environment, which could also be mediated by parental experiences. These findings are consistent with results in a non-twin sample suggesting that in dyadic interactions, boys tend to evoke positive responses from their mothers, whereas mothers tend to evoke positive responses from their daughters (Robinson et al. 1993).

Bivariate Cholesky genetic decompositions were conducted to estimate the magnitude of the genetic versus environmental influences shared in common between child characteristics that were significant, independent correlates of positive parenting (i.e., child cognitive ability and affection) and positive parenting. In boys, there were common genetic influences on positive parenting behaviors and child affection, whereas in girls, there were common shared environmental influences on positive parenting behaviors and child affection. Further, the results of the bivariate analysis of child general cognitive ability and positive parenting behaviors suggested that in girls, there were common shared environmental influences on positive parenting behaviors and child general cognitive ability; neither genetic nor environmental influences had significant effects on the covariance between child general cognitive ability and positive parenting in boys. The findings are consistent with the many studies that suggest both child characteristics (i.e., child affection and child general cognitive abilities) and parent characteristics that contribute to the child's genes and shared environment influence parenting behaviors (Deater-Deckard and O'Connor 2000; Klahr et al., 2015; Neiderhiser et al. 2004).

Implications

Numerous parenting training interventions guide parents toward more positive parenting approaches with notable success (e.g. Parent-Child Interaction Therapy, Triple P-Positive Parenting Program; Serketich and Dumas 1996; Thomas and Zimmer-Gembeck 2007); the findings from this study can help inform such interventions. In particular, the present study suggests the importance of child characteristics and gender in contributing to positive parenting behaviors, even after controlling for maternal characteristics. Parenting interventions may benefit from helping mothers to appreciate that parenting of boys and girls may differ due to affectionate display differences in boys and girls. Highlighting the role of

child gender in the quality of parent–child interactions may be important in shaping parenting behaviors.

Strengths, limitations, and future directions

This study has many strengths. It was a genetically informative study, which allowed us to examine the magnitude of genetic versus environmental influences on positive parenting. Further, observed measures of parenting behaviors were examined, which may provide a more accurate representation of parenting behaviors than self-report measures. There were multiple measures of many constructs across ages, providing a more representative estimate of several characteristics and behaviors.

However, the observed measure of parenting could also be considered a limitation of the study, as it may provide a snapshot of parenting that is not truly characteristic of parenting behaviors more generally. Nonetheless, because we collected and averaged observations of parenting across six time points, our observed measure is likely representative of these behaviors in the triadic play context that twins may often experience. Notably, the study has a relatively small sample size for a genetic study, further exacerbated by missing data across ages. Due to the amount of missing data, we had to examine average positive parenting across the ages, rather than taking advantage of longitudinal data by conducting longitudinal analyses (e.g., latent growth curve analyses). Thus, we were unable to address fully the direction of effect between child characteristics and parenting behaviors or to analyze possible mediation effects of child characteristics in the association between gender and parenting behaviors because child characteristics and positive parenting behaviors were assessed in the same interactions (Cole and Maxwell 2003). Additional studies with larger samples and more complete data are needed to better determine the direction of influence between child characteristics and positive parenting behaviors and to investigate possible mediators of the association between child gender and parenting behaviors.

Generalizability of the results should be considered. Our lack of data from the fathers is a limitation of the present study that prevents us from obtaining a more thorough picture of positive parenting behaviors, particularly given the role of interaction between parent and child gender. The influence of cultural norms specific to non-Hispanic Caucasians should be considered, given the lack of diversity in the sample. Also, there may be intrafamilial factors specific to raising twins rather than singleton children. A final limitation is that child affection and positive parenting were coded during the same interaction and coded by the same raters, which is different from other predictor variables (e.g., child general cognitive abilities, child temperament) that do not have a transactional association between observed child characteristics and parent behaviors. This introduces possible bias, as the child may have reacted to positive parenting behaviors by acting more affectionate during the observed coding segment, or the parent may have engaged in more positive parenting due to high child affection, although it also supports the transactional nature of parent–child interactions. These possibilities cannot be separated in the current sample due to missing data, and thus measures of child affection that are distinct from measures of parenting behaviors are necessary for causal conclusions in future studies.

Although a number of studies have examined the role of rGE in parenting (Klahr & Burt, 2014), to our knowledge this is the first study to find significant gender differences in the magnitude of genetic and environmental influences on positive parenting behaviors; thus, there is a need for replication. In future studies, it will be important to examine other independent measures of child affection that may be associated with positive parenting to ensure that the association between child affection and positive parenting extends more broadly and is not simply a result of the observed transactional interaction.

Conclusions

The present study found that both mother and child characteristics were significantly associated with positive parenting, but only child general cognitive ability and affection were independent correlates of parenting after controlling for maternal characteristics. Child gender was associated with positive parenting, with girls receiving more positive parenting behaviors than boys. However, the influence of gender on parenting was no longer significant after controlling for child cognitive ability and child affection, the significant independent correlates of positive parenting. This suggests that gender differences in other child characteristics may account for gender differences in received positive parenting. Gender differences were also observed in the results of genetic analyses. Parenting of boys may be influenced by evocative rGE (i.e., the children's genetic characteristics), whereas the parenting of girls may be more influenced by passive rGE (i.e., the parents' genetic characteristics) or shared environmental influences, which may be influenced by experiences of the parent. Although additional studies need to address the limitations in our methodology, the present study provides a good foundation regarding the role of mother and child characteristics and gene–environment correlation in the etiology of positive parenting behaviors.

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Appendix

Table 5

Sample size for each variable at each time point

Age (months)	Female N	Male N	Total N
Maternal sensitivity			
7	156	152	308
9	164	122	286
14	212	216	428
20	97	135	232
24	240	246	486
36d	140	101	241
36t	158	118	276

Age (months)	Female N	Male N	Total N
Maternal quality of instruction			
7	156	152	308
9	164	122	286
14	212	216	428
20	97	135	232
24	240	246	486
36t	158	119	277
Maternal warmth			
7	156	152	308
9	164	122	286
14	212	216	428
20	97	135	232
24	240	246	486
36d	140	101	241
36t	158	119	277
Child affection			
7	155	152	307
9	164	122	286
14	212	216	428
20	97	135	232
24	240	246	486
36d	140	101	241
36t	158	119	277
Child enthusiasm for interaction			
7	156	152	308
9	164	122	286
14	212	216	428
20	97	35	132
24	240	246	486
36d	140	101	241
36t	158	119	277
Maternal age			
0	484	474	958
Maternal IQ			
1/7 years	458	458	916
Child general cognitive ability			
14	387	396	783
20	334	356	690
24	343	353	696
36	442	325	767
Child expressive language			
14	386	391	777

Age (months)	Female N	Male N	Total N
20	340	358	698
24	339	344	683
36	335	313	648
Child receptive language			
14	386	393	779
20	341	351	692
24	332	333	665
36	343	317	660
Maternal education			
–	484	474	958
Maternal job prestige			
14	404	408	812
Paternal job prestige			
14	392	400	792
Child negative emotionality			
14	390	398	788
20	341	367	708
24	348	356	704
Maternal neuroticism			
14	332	340	672
36	226	240	466
Maternal marital satisfaction			
14	332	338	670
36	286	300	586
Paternal marital satisfaction			
14	236	232	468
36	182	182	364

Note At age 36 months, twins participated in dyadic interactions between one twin and the mother and in triadic interactions between both twins and the mother, which are labeled 36d and 36t respectively

Table 6

Means and standard deviations of independent and dependent variables, split by child gender

	Overall	Male	Female
Maternal sensitivity *	3.76 (0.57)	3.68 (0.56)	3.83 (0.58)
Maternal warmth ⁺	2.24 (0.59)	2.30 (0.59)	2.19 (0.59)
Maternal quality of instruction *	3.24 (0.73)	3.16 (0.76)	3.32 (0.68)
Maternal neuroticism *	9.93 (4.65)	10.63 (4.92)	9.20 (4.25)
Maternal education	14.44 (2.06)	14.34 (2.06)	14.53 (2.05)
Maternal age	29.65 (4.48)	29.59 (4.57)	29.70 (4.40)
Maternal IQ	104.86 (12.35)	104.20 (12.19)	105.52 (12.49)
Maternal marital satisfaction	110.66 (16.01)	109.39 (17.22)	111.37 (14.65)
Paternal marital satisfaction	110.65 (15.04)	110.07 (15.88)	111.28 (14.09)

	Overall	Male	Female
Maternal job prestige	38.77 (16.44)	37.68 (16.11)	39.86 (16.71)
Paternal job prestige	48.28 (13.50)	47.98 (13.57)	48.58 (13.45)
Child Bayley MDI *	130.46 (9.05)	129.56 (8.58)	131.37 (9.42)
Child stanford binet IQ *	103.13 (17.70)	100.34 (17.37)	105.77 (17.62)
Child enthusiasm for interaction *	3.36 (0.67)	3.28 (0.64)	3.45 (0.69)
Child affection *	3.23 (0.67)	3.12 (0.63)	3.34 (0.68)
Child negative emotionality	0.38 (0.12)	0.38 (0.11)	0.38 (0.12)
Child receptive language *	26.18 (6.15)	25.26 (6.32)	27.11 (5.84)
Child expressive language *	24.16 (5.01)	23.53 (4.93)	24.79 (5.02)

Note Means are averaged across multiple time points for variables assessed more than once

* $p < 0.05$ and

+ $p < 0.10$ for the difference between boys' and girls' parameters

Table 7

Correlations between predictor variables

Independent variables	1	2	3	4	5	6	7	8	9	10	11	12	13
1 Maternal Neuroticism (14 months)													
2 Maternal Neuroticism (36 months)	0.75 **												
3 Maternal Education	-0.08	0.02											
4 Maternal Age	-0.06	-0.11 +	0.42 **										
5 Maternal IQ	-0.18 **	-0.15 *	0.49 **	0.34 **									
6 Maternal Marital Satisfaction	-0.38 **	-0.34 **	0.14 *	-	0.01	0.19 **							
7 Paternal Marital Satisfaction	-0.28 **	-0.26 **	0.13 *	-	0.05	0.12 +	0.89 **						
8 Maternal Socioeconomic Status	-0.09 *	-0.02	0.43 **	0.18 **	0.22 **	0.03	0.02						
9 Paternal Socioeconomic Status	0.00	0.06	0.38 **	0.24 **	0.34 **	0.12 *	0.03	0.17 **					
10 Child Affection	-0.12 *	0.12	0.13 *	0.06	0.10 +	0.10	0.08	-0.02	0.04				
11 Child Negative Emotionality	0.05	0.08	-0.09	-	0.14 *	-0.08	-0.06	-0.09	0.03	-0.06	0.11		
12 Child General Cognitive Ability	-0.12 *	-0.03	0.38 **	0.14 **	0.25 **	0.12 +	0.17 *	0.18 **	0.20 **	0.15 **	-0.29 **		
13 Child Receptive Language Abilities	-0.11 *	-0.04	0.28 **	0.13 *	0.14 *	0.14 *	0.200.20 **	0.15 **	0.16 **	0.09	-0.27 **	0.98 **	
14 Child Expressive Language Abilities	-0.10 +	0.00	0.31 **	0.10 +	0.23 **	0.16 *	0.15 *	0.16 **	0.14 *	0.14 *	-0.27 **	0.99 **	0.96 **

Note Variables 10–14 are latent variables. $n = 972$

+ $p < 0.10$,

* $p < 0.05$,

** $p < 0.01$

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Fig. 1.

Univariate genetic model of positive parenting behaviors. Parameters for boys are on top and those for girls are on bottom. Above the latent factor are genetic, shared environmental, and non-shared environmental estimates, which were all estimated and not fixed. Below the latent factor are loadings on each manifest variable. The loading on maternal sensitivity was fixed to be 1 and residual variance was fixed to be 0; standardized estimates are shown. Specific As, Cs, and Es for maternal sensitivity, maternal warmth, and maternal quality of instruction were estimated but not shown for the sake of simplicity. Statistical significance of the parameters was determined by p -values of z -tests based on ratios of parameters/standard errors. $n = 324$. * $p < 0.05$

Fig. 2.

Bivariate Cholesky genetic decomposition of child affection and positive parenting behaviors. Parameters for boys are on top and those for girls are on bottom. Above the latent factors are genetic, shared environmental, and nonshared environmental estimates, which were all freely estimated. Below the latent factors are loadings on each manifest variable. Specific As, Cs, and Es for all maternal and child variables were estimated but not shown for the sake of simplicity. Statistical significance of the parameters was determined by *p*-values of *z*-tests based on ratios of parameters/standard errors. *n* = 324. **p* < 0.05

Fig. 3.

Bivariate Cholesky genetic decomposition of child cognitive abilities and positive parenting behaviors. Parameters for boys are on top and those for girls are on bottom. Above the latent factors are genetic, shared environmental, and nonshared environmental estimates and below the latent factors are loadings on each manifest variable. To allow for model convergence, the shared environmental estimate unique to positive parenting was fixed to be 0 in boys, and the additive genetic estimate unique to positive parenting was fixed to be 0 in girls. Specific As, Cs, and Es for all maternal and child variables were estimated but not shown for the sake of simplicity. Statistical significance of the parameters was determined by p -values of z -tests based on ratios of parameters/standard errors. $n = 409$. * $p < 0.05$

Table 1

Global coding scheme scale descriptions and observed percentages across ages

Brief description	%
Mother variables	
Sensitivity to cues from child	
Fails to be supportive to child	1
Gives minimal support to child	6
Gives some sporadic support to child	23
Provides adequate support to child	49
Skillfully provides support throughout	21
Quality of instruction	
Instructions absent, ineffective, or poor quality	4
Provides minimal structure and instruction	20
Provides adequate structure and instruction	30
Actively involved with adequate instruction	34
Highly involved with clear overall explanation	12
Warmth (reverse coded)	
Highly affectionate throughout interaction	20
Mostly affectionate, frequent cuddling of child	43
Moderate and sporadic affection	28
Little or rare affection	8
No affection, some avoidance behaviors	1
Child variables	
Affection for mother	
Does not attempt to share experience	5
Rarely shows positive affect towards mother	21
Shares some positive expressions with mother	32
Shows positive affect for majority interaction	29
Demonstrates a positive, engaging relationship	13
Enthusiasm for interaction with mother	
Actively avoids interaction, reacts negatively	3
Displays active or passive avoidance	16
Shows some enthusiasm, still hesitant	32
Enthusiastic for majority of interaction	33
Shows positive affect, confidence throughout	16

Table 2

Correlations with positive parenting

Independent variables	Correlation	Number of observations
Maternal neuroticism	– 0.09 ⁺	801
Maternal education	0.19 [*]	955
Maternal age	0.07	955
Maternal IQ	0.10	935
Maternal marital satisfaction	0.18 [*]	801
Paternal marital satisfaction	0.18 [*]	780
Maternal socioeconomic status	0.03	820
Paternal socioeconomic status	0.09	820
Child affection	0.70 [*]	611
Child negative emotionality	– 0.10	820
Child general cognitive ability	0.22 [*]	824
Child receptive language abilities	0.17 [*]	824
Child expressive language ability	0.17 [*]	824

*
 $p < 0.05$.⁺
 $p < 0.10$

Table 3

Standardized regression coefficients from multiple regression analyses correlated with positive parenting

Child general cognitive ability	0.15 *
Child affection	0.68 *
Maternal neuroticism	-0.01
Maternal years education	0.08
Maternal marital satisfaction	0.11
Paternal marital satisfaction	0.02

Note $n = 958$ *
 $p < 0.05$

Table 4

Within-trait and cross-trait twin correlations

	Parenting	Child affection	Child GCA	Parenting & child affection	Parenting & child GCA
Males					
Phenotypic				0.73**	0.29**
Monozygotic	0.66**	0.40**	0.99**	0.51**	0.25**
Dizygotic	0.32*	0.30*	0.81**	0.28*	0.23*
Females					
Phenotypic				0.69**	0.41**
Monozygotic	0.44**	0.46**	1.00**	0.36**	0.40**
Dizygotic	0.55**	0.55**	0.72**	0.41**	0.67**

Note Correlations could not be equated between males and females, so separate parameters are shown. The high MZ cross-twin correlation is a result of evaluating correlations between latent variables with loadings on multiple timepoints. In variables like GCA that are very similar between MZs, it is common to see cross-twin within-time correlations that are greater than within-twin cross-time correlations, which can lead to cross-twin correlations for latent variables that are very high and can even be estimated greater than 1.00. The greater DZ than MZ correlation is not meaningful, as the correlations are not significantly different from each other. This result is similar to that of a previous study examining a subset of the present study's sample that found the same pattern of results in independent analyses (e.g., Boeldt et al. 2012). $n = 409$. GCA = General Cognitive Ability

* $p < 0.05$,

** $p < 0.01$