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Genetic Influences Can Protect Against Unresponsive Parenting in the Prediction of Child Social Competence

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Abstract

Although social competence in children has been linked to the quality of parenting, prior research has typically not accounted for genetic similarities between parents and children, or for interactions between environmental (i.e., parental) and genetic influences. In this paper, we evaluate the possibility of a gene-by-environment (GxE) interaction in the prediction of social competence in school-age children. Using a longitudinal, multi-method dataset from a sample of children adopted at birth (N = 361), we found a significant interaction between birth parent sociability and sensitive, responsive adoptive parenting when predicting child social competence at school entry (age 6), even when controlling for potential confounds. An analysis of the interaction revealed that genetic strengths can buffer the effects of unresponsive parenting.

Keywords

social competence; parenting; adoption design; GxE interaction

Social competence is a key landmark in child development (Sroufe, 1979) and thus is often the target of empirical research. Although several different approaches to the study of social competence in children have emerged over time (Ladd, 1999), a common definition involves effectiveness in interpersonal interactions (Waters & Sroufe, 1983). Social competence is therefore not simply the absence of behavioral problems, but is comprised of adaptive social

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characteristics. Within this broad definition, operationalizations of social competence generally refer to specific skills and behaviors, but may also include the attainment of high social status or the quality of interpersonal relationships (Rose-Krasnor, 1997). In this paper, we examine the predictors of social competence in school-age children, with an emphasis on the behavioral aspects of social competence, which include cooperation, communication, responsibility, and self-control in social interactions (Rose-Krasnor, 1997).

Existing research on social competence among school-age children finds that socially competent children are more successful in establishing valuable personal relationships with peers and teachers and, as a result, are able to obtain support from others as needed to attain specific goals, resolve problems, or cope with personal distress (Ladd, Birch, & Buhs, 1999; Sroufe, 1983). A greater degree of social competence during the transition to school has been found to contribute to a host of beneficial long-term outcomes, including increased academic success and reduced risk of externalizing and internalizing problems (Bornstein, Hahn, & Haynes, 2010; Burt, Obradović, Long, & Masten, 2008; Ladd et al., 1999; Malecki & Elliot, 2002; Welsh, Parke, Widaman, & O'Neil, 2001). Social skill deficits, in contrast, can trigger a cascade of negative experiences, leading to higher levels of substance use and aggressive behavior in late adolescence (Dodge, Greenberg, & Malone, 2008; Dodge et al., 2009).

Parenting is considered to be a key contributor to the development of social competence in children and adolescents (Lengua, Honorado, & Bush, 2007; Pettit, Dodge, & Brown, 1988). Based on theories of attachment (Bowlby, 1969) and social cognition (Bandura, 1986), contingent parental responsiveness in infancy and childhood is hypothesized to promote the development of internal representations or working models that anticipate interpersonal interactions as a source of pleasure and safety; in contrast, children with a history of rejecting, neglecting, or inconsistent care develop models of others as unresponsive, unreliable, and potentially hurtful (Ainsworth, 1989; Bretherton, 2005; Sroufe, 1988; Sroufe & Fleeson, 1986). Typically, assessment of parental sensitivity and responsiveness includes the tendency to be supportive, affectionate, and aware of the child's needs, to express approval when the child exhibits positive behavior, and to direct positive verbal expressions and positive affect toward the child (Darling & Steinberg, 1993). As children gain more sophisticated cognitive skills during the preschool period, they are able to observe and internalize parents' interpersonal behavior, and these scripts and models are used to guide their behavior in new settings, such as interactions with peers (Patterson, Reid, & Dishion, 1992; Sroufe, Egeland, & Carlson, 1999). Thus, parenting that is sensitive and responsive can contribute to higher levels of socially competent behavior and lower levels of incompetent or antisocial behavior in toddlers and school age children (Brody & Flor, 1998; Elicker, Englund, & Sroufe, 1992; Hart, Newell, & Olsen, 2003). Similarly, children that rarely experience parental sensitivity and responsiveness have been shown to be less sensitive and less responsive with peers (Lindsey, Mize, & Pettit, 1997). Sensitive and responsive parenting has also been linked to the development of empathy (Zhou et al., 2002) and self-regulation (Brody, Flor, & Gibson, 1999) in children, which in turn support the development of social competence.

Some studies have failed to find a link between parenting and child social competence (e.g., Brody et al., 1999), which raises the question of whether other factors may be in play. One such factor could be shared genes between parent and child, since much of the parenting research has been conducted using biological families. Indeed, research with twins and adopted children has found a substantial genetic basis for many aspects of social behavior (Edelbrock et al., 1995). For example, genetic influences have been found for self-disclosure in social interactions with family, teachers, and peers among both school-aged children and adolescents (Manke, McGuire, Reiss, Hetherington, & Plomin, 1995; Manke & Plomin, 1997; for review see Manke & Pike, 2003). The extant literature also contains examples of research on toddlers and school-age children in which genetic influences explain half or more of the total variance in important precursors to social competence, such as self-regulation (Goldsmith, Buss, & Lemery, 1997), social relatedness (Van Hulle, Lemery-Chalfant, & Goldsmith, 2007), and sociability (Eid, Riemann, Angleitner, & Borkenau, 2003; Schmitz, Saudino, Plomin, Fulker, & DeFries, 1996); this research mainly used twin designs and questionnaire measures, although Van Hulle et al. (2007) used a parent interview measure. Boivin and colleagues (2013) have also found significant genetic contributions to social difficulties in elementary school as assessed by sociometric nominations and interview data.

In addition to genetic influences on social behavior, research has found a substantial genetic basis for the quality of parenting (Horwitz & Neiderhiser, 2011; Kendler & Baker, 2007; Reiss, Neiderhiser, Hetherington, & Plomin, 2000). For example, studies of parents who were identical or fraternal twins or adoptive siblings suggests that there are genetic effects on self-reports of parenting, including parental warmth (Losoya, Callor, Rowe, & Goldsmith, 1997). Other research has found evocative gene-environment (*r*GE) effects for both parental warmth and responsiveness (Deater-Deckard, 2000), in which genetic factors were found to play a role in the elicitation of these parenting behaviors. Evidence for evocative *r*GE has been found for related aspects of parenting, such as parent-child mutuality (Deater-Deckard & O'Connor, 2000). In addition, research has found evidence for evocative *r*GE effects linking negative parenting and child behavioral problems (Braungart-Rieker, Rende, Plomin, DeFries, & Fulker, 1995; O'Connor, Deater-Deckard, Fulker, Rutter, & Plomin, 1998). These results suggest that there are a variety of mechanisms by which genes could influence parenting and child behavior as well as the link between them.

Notably, there is also evidence for the effects of the environment, rather than genetics, on precursors to and correlates of social competence in toddlers and school-age children, such as positive affectivity (Goldsmith et al., 1997), attachment classification (O'Connor & Croft, 2001), and helping behavior (Volbrecht, Lemery-Chalfant, Akzan, Zahn-Waxler, & Goldsmith, 2007). In addition, Van Hulle and colleagues (2007) found evidence for both genetic and shared environmental influences on a broad assessment of competency in young children (i.e., sustained attention, empathy, imitative play, motivation, and compliance with parents). These findings and those discussed above suggest that the development of social competence in young children may be influenced by *both* the environment (i.e., parenting) and shared genes, which would be considered an “additive” model. An intriguing possibility is that parenting may *interact* with inherited qualities when predicting social skill outcomes

in children (Repetti, Taylor, & Seeman, 2002). Although no research exists to support a parenting-by-genetics hypothesis in relation to social competence, the literature does contain evidence that genetic vulnerabilities can be moderated by sensitive, responsive parenting in the development of problem behavior. For example, using an adoption sample, Natsuaki and colleagues (2010) found that responsive parenting moderated the influence of genetic risk factors (as quantified by the presence of major depressive disorder in the birth mother) when predicting infant fussiness. Interaction effects involving parenting and genetic factors have also been found when predicting young children's aggression or problem behaviors (Brendgen et al., 2008a; Brendgen et al., 2008b; Leve et al., 2009). In the molecular genetic literature, a dopamine receptor polymorphism was found to moderate the link between insensitive maternal parenting and externalizing behavior in preschool-aged children (Bakermans-Kranenburg & Van IJzendoorn, 2006), and there is evidence for genetic moderation of the link between parenting and both attachment security (Barry, Kochanska, & Philibert, 2008) and attachment disorganization (Gervai et al., 2007; Spangler, Johann, Ronai, & Zimmerman, 2009) as assessed by the Strange Situation.

In the current study, we examined the main effects of shared genes and environmental (i.e., caregiving) influences, as well as their interaction, when predicting social competence in school-age children. We used an adoption sample in which children were placed in a non-relative adoptive home within the first weeks of life. When design assumptions are met (i.e., no selective placement, and prenatal factors are adequately controlled), the adoption design rules out the possibility of genetic influences due to shared genes between parent and child (i.e., passive *r*GE). As a marker of genetic influence, we selected birth parent sociability, which not only has a significant genetic component (Eid et al., 2003) but also has been directly linked to the development of social competence (Rubin, Hymel, & Mills, 1989).

Consistent with previous research, we hypothesized that early adoptive parenting and birth parent genetic influences would both have significant main effects on child social competence during the transition to school. We also hypothesized that these two predictors would have a significant interaction term, with one predictor moderating the impact of the other. Specifically, we would normally expect insensitive and unresponsive parenting to lead to lower levels of social competence, but genetic advantage could serve as a protective factor, such that high birth parent sociability can promote the development of social competence despite insensitive and unresponsive adoptive parenting. Similarly, sensitive, responsive parenting may serve as a protective factor that promotes the development of social competence even among children at genetic risk due to low birth parent sociability.

We utilized a multi-method, multi-reporter approach to capture adoptive parenting and children's social competence, and we assessed genetic influences using measures of birth mothers' and fathers' sociability (which, as noted above, has been found to have a significant genetic component and has been linked to the development of social competence). To test for moderation effects on child social competence, we included an interaction term between birth parent sociability and adoptive parenting (see Figure 1).

As discussed above, an adoption design can eliminate passive *r*GE effects; however, it cannot account for evocative *r*GE effects in which an inherited (i.e., genetic) aspect of child

personality or behavior elicits a certain kind of parenting. To control for this possibility, we included child positive emotionality in our model (see Figure 1). Previous research has established a genetic link between sociability and positive emotionality (Eid et al., 2003), and positive emotionality could not only influence adoptive parenting, but has also been linked to the development of social competence (Lengua, 2003; Lengua & Kovacs, 2005; Sallquist et al., 2009), suggesting the possibility of an evocative *r*GE effect. By controlling for child positive emotionality in our analysis, we would be more confident that our genetic (i.e., birth parent sociability) and environmental (i.e., adoptive parenting) effects were independent.

Method

Participants

The current investigation uses families from the Early Growth and Development Study Cohort I (EGDS; Leve et al., 2013). The EGDS is a prospective longitudinal adoption study of children, their adoptive parents, and their birth parents. The EGDS Cohort I (N=361) was drawn from 33 adoption agencies in 10 states from three regions in the United States: the Northwest, West/Southwest, and Mid-Atlantic. The eligibility criteria for including families in the study were the following: (a) the adoption placement was domestic, (b) the infant was placed within 3 months postpartum (M = 7.11 days postpartum, SD = 13.28; median = 2 days), (c) the infant was placed with a non-relative adoptive family, (d) birth and adoptive parents had attained an eighth-grade level or higher level of education, and (e) the infant had no known major medical conditions such as extreme prematurity or extensive medical surgeries. Forty-three percent of the children in the EGDS are female. Fifty-eight percent of the children are Caucasian, 21% are mixed race, 11% are African-American, and 11% are other or unknown. The mean ages of the adoptive mothers, adoptive fathers, birth mothers, and birth fathers at the birth of the child were 38 (SD = 5.5), 38 (SD = 5.8), 24 (SD = 5.9), and 25 (7.2), respectively. More than 90% of the adoptive mothers and fathers were Caucasian. The birth mother and birth father sample, respectively, is 71% and 75% Caucasian, 11% and 9% African-American, 7% and 9% Hispanic, and 11% and 8% multiethnic or unknown. Detailed information regarding sample recruitment, characteristics, and the overall project design is available in Leve et al. (2013). Birth fathers participated in approximately 35% of the families. A comparison of cases revealed that the presence of the birth father in the study was associated with slightly lower scores on adoptive mother-reported child social competence as compared to families where the birth father did not participate (r = −.14, p < .05; R^2 = .02); no other significant links were found with any other study variable (15 comparisons overall), which corresponds to the expected Type I error rate (i.e., 5%).

Procedures

Adoptive families were assessed longitudinally during in-person assessments in the families' home that lasted 2 ½ to 4 hrs. In the present study, data from assessments at 9-mo (child positive emotionality), 27-mo (adoptive parenting), and 6 years (child social competence) were included. Birth parents were also assessed longitudinally by means of in-person interviews; data from assessments at 18-mo (sociability) were included in analyses. For both

the birth- and adoptive-parent assessments, interviewers asked participants computer-assisted interview questions, and each participant independently completed a set of questionnaires. Adoptive families also participated in tasks in which their behavioral responses were observed and recorded onto digital media. For children enrolled in Kindergarten, questionnaires were mailed to their Kindergarten teachers (upon receiving the consents from the adoptive parents indicating that the teachers could be contacted). Separate teams of interviewers conducted assessments of birth parents and adoptive families such that within each birth parent-adoptive family unit, the interviewer was completely blind to data collected by the other interviewer.

Measures

Child social competence—As noted by Waters and Sroufe (1983), the key to age-appropriate assessment of social competence is to select issues central for the developmental period. We assessed child competence at age 6 using reports of social behavior from adoptive mothers, adoptive fathers, and teachers that were combined into a single latent construct. Adoptive mother and father reports of social competence were measured using the Social Skills Rating System (SSRS; Gresham & Elliott, 1990). The SSRS can be used with preschool, elementary, and secondary school students. We used the Total Social Skills measure, which includes 39 items (α = .87 for mother ratings and .88 for father ratings) reflecting parent perceptions of child cooperation, communication, responsibility, and self-control in interactions with peers and adults.

Teacher reports of child social competence were measured using the Peer-Preferred Social Behavior subscale of the Walker McConnell Scale of Social Competence and School Adjustment (Walker & McConnell, 1988). This subscale comprises 17 items (α = .94) reflecting teacher perceptions of the quality of the child's social competence and peer relations. The reports of child social competence from adoptive parents and teachers were moderately correlated (see Table 1), justifying the aggregation of scores across informants into a latent construct.

Adoptive parenting—Parenting by adoptive parents was assessed at age 27 months during the in-home assessment. We used two separate observational measures that were combined into a single latent construct. First, we used the Emotional and Verbal Responsiveness subscale of the Home Observation for Measurement of the Environment (HOME; Caldwell & Bradley, 1984). Previous research has found that the HOME can predict developmental outcomes in both low-risk and at-risk populations (Elardo & Bradley, 1981; Totsika & Sylva, 2004). The Emotional and Verbal Responsiveness subscale comprises 11 items (α = .59 for mothers and .68 for fathers) reflecting interviewer ratings of emotional and verbal responsiveness (e.g., whether the parent “spontaneously praises child's qualities or behavior”, “responds to child's vocalizations”, “caresses or kisses child”, and whether the parent's voice “conveys positive feeling”).

Second, we used interviewer ratings of parental sensitivity, responsiveness, and guidance during two tasks (clean-up and teaching) in which the child participated separately with each parent. In the first task, the interviewer instructed the parent to have the child clean up all the

toys with which they have been playing. In the second task, the interviewer gave the parent and child a puzzle to solve; each parent received a different puzzle of relatively equal difficulty to ensure the child would not solving the same puzzle twice. The parent was instructed to try to let child do the puzzle on her/his own, but to offer any help s/he thought was necessary. The interviewer provided global impressions of overall parental responsiveness across these tasks during the home visit (two items overall, one for each parent) and parental sensitivity and guidance during each task (four items overall, two for each parent and two for each task) using the following scale: very true (1), somewhat true (2), hardly true (3), and not true (4). These items were reverse-coded before analysis so that higher scores indicated greater sensitivity and responsiveness. Interviewers were trained on the rating system prior to going into the field and were instructed that the items should represent their "impressions", as intended by the original measure (Weinrott, Reid, Bauske, & Brummett, 1981); thus, these data represent an independent assessment by a single individual that is similar to teacher or parent ratings in that regard. Interviewer ratings done in this manner have been shown to correlate with coded observations and child behavioral outcomes in previous research (Weinrott et al., 1981) and have been used in similar ways in other published work (e.g., Capaldi et al., 2012). In general, the measures of adoptive parenting were moderately correlated across informants (see Table 1).

Birth parent sociability—The Sociability subscale of the Adult Temperament Questionnaire (ATQ; Evans & Rothbart, 2007) indexed sociability for birth parents. The ATQ is a self-report model of temperament that includes general constructs of effortful control, negative affect, extraversion/surgency, and orienting sensitivity. The Sociability subscale (5 items; α = .72 for birth mothers and .74 for birth fathers) is a component of extraversion/surgency that has been found to be heritable (Eid et al., 2003) and has been directly linked to the development of social competence in children (Rubin et al., 1989). Because the birth mother and father measures of sociability were not significantly correlated (r = .16), the use of both measures in a single latent variable would have resulted in suboptimal model fit; thus, we standardized and averaged the two measures before the analysis (when birth father data were not available, we used birth mother data alone). By averaging the measures from both mother and father, we were able to infer the sum total of the genetic influences as inherited from both parents, which we deemed superior to limiting our analysis to only the maternal measure. However, we also conducted a sensitivity analysis in which we re-analyzed the data using only the maternal measure of sociability in order to evaluate whether our combined approach introduced bias to the results.

Child positive emotionality—We assessed adoptive parent reports of the child's early positive emotionality using the Smiling and Laughter subscale (15 items; α = .83 mothers and .86 fathers) of the Infant Behavior Questionnaire (IBQ; Rothbart, 1981) at 9 months. These were expected to be correlated (see Table 1), so we included both adoptive mother and adoptive father reports in a single latent construct.

Other covariates—We assessed prenatal influences and contact between birth and adoptive parents (openness in adoption) as covariates. Prenatal influences were included to control for any pregnancy-related issues that may impact future child functioning and be

confounded with genetic influences. A prenatal risk index score was derived using the McNeil–Sjostrom Scale for obstetric complications (McNeil & Sjostrom, 1995) which assesses: (a) maternal/pregnancy complications (including illness, fetal distress during this period, exposure to drugs/alcohol, maternal stress and psychopathology, and psychotropic drug use), (b) labor and delivery complications (prolonged labor, cord complications, interventions needed), and (c) neonatal complications (prematurity, low birth weight). A total score was created by summing across the 3 areas of complications (Marceau et al., 2013).

Openness in adoption was included in the analyses to control for similarities between birth and adoptive families that may have resulted from exchanges between parties. At age 6, we measured the level of openness in adoption using independent reports from adoptive mothers and fathers (for details, see Ge et al., 2008) about perceived openness (a 7-point scale ranging from 1 = very closed to 7 = very open). Mother and father reports were averaged to arrive at the final score ($r = .73$, $p < .001$).

Analysis Plan

To estimate the size of main effects independent of covariates, we initially fit a model with only birth parent sociability, adoptive parenting, and child social competence. Next, we added child positive emotionality and covariates and re-fit the model. Both prenatal influences and openness in adoption were found to be uncorrelated with the other variables in the model and were removed from further consideration. Finally, we created an interaction term between adoptive parenting and birth parent sociability in order to test for the possibility of moderation effects; as adoptive parenting was a latent construct and birth parent sociability was a combination of standardized variables, both components of the interaction term were already centered. If significant results were found for the interaction term, we then calculated regions of significance (Preacher, Curran, & Bauer, 2006), which define the specific values of one predictor (z) at which the regression of the outcome (y) on the other predictor (x) moves from non-significance to significance.

Because our adoptive parenting construct contained multiple measures from different sources on different individuals (i.e., mother and father), we considered it to be Multitrait-Multimethod (MTMM) data, and thus explicitly accounted for the likelihood that measures involving the same individual or using the same method may correlate more highly with one another than with the rest of the measures within the latent construct (Kenny, 1976; Marsh, 1989; Saris & Aalberts, 2003). Specifically, we allowed the error terms for measures of parenting by the adoptive mother to correlate with one another (and similarly for the adoptive father), and we also allowed the error terms for the different measurement instruments to correlate (e.g., the HOME). We then evaluated whether these correlations contributed significantly to model fit; if not, they were discarded. In reporting the results, we specified the correlations that were retained. Finally, we conducted a sensitivity analysis in which all correlations were removed and the models were re-fit to determine whether the correlations had a significant impact on the results.

To fit the models, we used structural equation modeling in Mplus 6.2 (Muthén & Muthén, 2008). We used robust maximum likelihood analysis, which can provide unbiased estimates

in the presence of both missing data and non-normality (e.g., our HOME measures were negatively skewed). When available, standard measures of fit are reported, including the chi-square (χ^2), comparative fit index (CFI), nonnormed or Tucker-Lewis index (TLI), and root mean square error of approximation (RMSEA). CFI values greater than .95, TLI values greater than .90, RMSEA values less than .05, and a nonsignificant χ^2 (or a ratio of χ^2/df < 3.0) indicate good fit (Bentler, 1990; Hu & Bentler, 1999).

Results

Item correlations and descriptive data are presented in Table 1. We did have a degree of missing data, but an analysis revealed that missingness in later waves (e.g., social competence) was not systematically related to variable values in earlier waves (e.g., adoptive parenting; no significant correlations out of 24). In addition, missingness in our key constructs (i.e., parenting, sociability, and social competence) was not related to family income (no significant correlations out of 16) or marital status (one significant correlation out of 16). However, we did find an indication of systematic attrition when considering ethnicity; in our sample, European-American birth and adoptive parents were somewhat more likely to have missing data as compared to non-European-Americans (four significant correlations out of 16). Thus, we conducted two additional analyses: (1) we examined whether the use of ethnicity as a predictor would alter the model results, and (2) we examined ethnicity as a moderator of model paths.

Our initial model contained birth parent sociability, adoptive parenting, and child social competence. Factor loadings were adequate except for the adoptive mothers' measure of “responsiveness” (loading = .22) and the Responsiveness subscale of the HOME (loading = .24), which were removed from the model. All measures of child social competence demonstrated adequate loadings (> .30). The only MTMM correlation retained was between the adoptive father measures of sensitivity and guidance in the teaching and clean-up tasks (r = .49, p < .001). Model fit was good, $\chi^2(33) = 34.72$, *ns*, CFI = .99, TLI = .99, RMSEA = .012 (95% CI: .000|.041). Adoptive parenting was not a significant predictor of child social competence (β = .06, *ns*), but birth parent sociability was a significant predictor (β = .17, p < .05; see Figure 2). These results did not vary when the MTMM correlation was removed, nor did they change when the two measures of adoptive mother parenting were re-added to the latent construct.

We then inserted child positive emotionality and re-fit the model. Model fit was good, $\chi^2(50) = 65.80$, *ns*, CFI = .97, TLI = .96, RMSEA = .029 (.000|.046). In this model, child social competence was significantly predicted by child positive emotionality (β = .22, p < .05), and the previous prediction by birth parent sociability was reduced to non-significance (β = .12, *ns*; see Figure 2). Birth parent sociability was significantly correlated with child positive emotionality (β = .18, p < .05) as would be expected. These results did not change when the MTMM correlation was removed, nor did they change when the two measures of adoptive mother parenting were re-added.

Finally, we added the interaction term between adoptive parenting and birth parent sociability. The interaction term was significant (B = −7.29, SE = 3.63, p < .05; no

standardized betas or model fit indices were provided by Mplus). The residual variance of the latent construct representing social competence decreased from 26.09 in the previous model to 24.31 ($p < .01$), suggesting that the interaction term explained an additional 7% of the variance. Our results did not change when the MTMM correlation was removed, nor did they change when the two measures of adoptive mother parenting were re-added. These results also did not change when we added ethnicity as a predictor, and in a separate analysis, ethnicity did not act as a moderator, $\chi^2(4) = 5.22$, *ns*. Finally, we conducted an additional sensitivity analysis using only birth mother sociability, and the interaction effect was still significant, $B = -5.95$, $SE = 2.60$, $p < .05$.

To explore the interaction term, we graphed the predicted values for child social competence in situations of low and high birth parent sociability (one standard deviation below and above the mean, respectively) and various levels of adoptive parent sensitivity and responsiveness (i.e., low sensitivity/responsiveness was 1 and 2 SD below the mean, whereas high sensitivity/responsiveness was 1 and 2 SD above the mean; Aiken & West, 1991; see Figure 3). The graph includes 95% confidence intervals for each data point. An examination of the graph suggests that the relationship between parenting and social competence differs as a function of birth parent sociability. In situations of low and very low adoptive parent sensitivity and responsiveness (i.e., the left half of the figure), children with high birth parent sociability were predicted to have a higher degree of social competence when compared to children of low birth parent sociability. In contrast, high and very high adoptive parent sensitivity and responsiveness predicted fairly uniform levels of social competence regardless of birth parent sociability (i.e., the right half of the graph); the confidence intervals overlapped in this area of the graph, so we can assume that there were no significant differences in child social competence for low as compared to high birth parent sociability.

To verify this interpretation, we calculated the regions of significance. Considering adoptive parenting to be the moderator, we found that the link between birth parent sociability and social competence became significant and positive at moderate levels of parenting sensitivity and responsiveness (i.e., −.06, just below the mean of zero; see Figure 3; simple slope = 1.14, SE = .58, $p = .05$). The link between sociability and social competence was negative at extremely high levels of sensitivity/responsiveness (i.e., .72, more than 4 SD above the mean) that were highly unlikely to be attained (this area is not represented in Figure 3). In between these points (i.e., at high or very high levels of sensitivity/responsiveness), the link between sociability and social competence was non-significant. In other words, in situations of environmental risk (i.e., unresponsive parenting), genetic influences from biological parents can serve as a protective factor and promote the development of social competence. Similarly, we can also view sensitive/responsive parenting as a protective factor, promoting the development of social competence in situations of genetic risk (i.e., low birth parent sociability).

Discussion

In this study, we hypothesized that both genetic influences and adoptive parenting in early childhood would be associated with child social competence during the transition to school,

and that the two would have interactive effects on child social competence. Prior to entering the covariates and interaction term, birth parent sociability predicted child social competence, suggesting a genetic main effect transmitted in the form of an inherited tendency to be sociable. However, once the covariates were included in the model, the effect of birth parent sociability was reduced to nonsignificance and toddler positive emotionality emerged as a key predictor of child social competence, which echoes other findings suggesting that positive emotionality is an important precursor to social competence (Lengua, 2003; Lengua & Kovacs, 2005; Sallquist et al., 2009). Toddler positive emotionality and birth parent sociability were significantly correlated in our model (see Figure 2), which corresponds to previous research that found a common genetic component for the two constructs (Eid et al., 2003); this correlation may also explain why the main effect of birth parent sociability was attenuated in this model.

When the interaction term between sensitive parenting and birth parent sociability was added to the model, it significantly predicted child social competence, suggesting a GxE effect. As seen in Figure 3, social competence was significantly lower among children with genetic vulnerabilities (i.e., birth parents that reported lower levels of sociability) whose adoptive parents demonstrated lower levels of sensitive, responsive parenting; in contrast, children of birth parents who were higher in sociability were not negatively impacted by the lack of sensitive, responsive parenting. This finding suggests that higher levels of birth parent sociability can confer a degree of inherited “resilience” in children, or a degree of protection against less responsive caregiving environments. On the opposite end of the continuum, there is evidence that children who received sensitive, responsive parenting were not negatively impacted by low levels of birth parent sociability; from this point of view, responsive parenting can be seen as a protective factor against genetic vulnerability. Although the graph of the interaction term suggested that responsive parenting could potentially be harmful for children with high birth parent sociability, the region of significance suggested that the attainment of this condition was extremely unlikely. Thus, it would be inappropriate to interpret this particular aspect of our findings.

These results add to the sparse literature examining GxE interactions in child development. In this study, inherited genetic advantage was found to buffer against low-quality parenting; it is only when both genetic influences and environments were below average that adverse effects were transmitted to the child. Given that previous research on GxE interactions in young children has focused on outcomes such as fussiness (Natsuaki et al., 2010) and problem behavior (Leve et al., 2009), the current study provides initial evidence suggesting that genetic influences can offset an environmental liability when predicting prosocial behavior. The adoption design methodology makes this finding particularly relevant for adoptive parents; rather than experiencing only concern over any birth parent problems or deficits, adoptive families can be reassured that genetic strengths are also transmitted to children. Relatedly, our results suggest that high-quality parenting can compensate for genetic liabilities related to social competence.

It was somewhat surprising that we did not find evidence for a main effect of sensitive parenting on child social competence, since prior work with school-age children has shown significant associations (Elicker et al., 1992; Hart et al., 2003). However, other research has

failed to find such a link (Brody et al., 1999) and as noted above, many of the existing studies are comprised of genetically-related parents and children, so our failure to find a significant link may be due to the nature of our sample (i.e., adopted children). The parenting measures used in this study may also have played a role in our results; although observational measures are generally considered to be among the strongest approaches to assessing parenting with young children, it is possible that our interviewer impressions underestimated the effects of parenting to an unknown extent. Replication of our results using more robust assessments of parenting would help to clarify this aspect of our findings.

In general, our results are strengthened by our adoption design, which removed shared genetic influence as a potential confounding factor and enabled us to focus on genetic and environmental influences (and their interaction) on behavior. Additional strengths include the longitudinal approach, the multi-method, multi-reporter data, and the use of additional controls such as positive emotionality to address the possibility of evocative *r*GE effects. We also evaluated measures of prenatal effects and the adoption process to establish that neither had a significant impact on the variables of interest.

Limitations and conclusion

This study possesses limitations that should temper the interpretation of the results. One area of concern was the degree of missing data (see Table 1) and link between patterns of missingness and ethnicity (see Results). However, our additional analyses incorporating ethnicity suggested that the pattern of missingness did not introduce significant bias into the results. We also found a few issues related to model fit; two parenting variables were dropped, and an MTMM correlation was required to ensure good model fit. However, our results did not change when the parenting variables were re-introduced to the model and the MTMM correlation was removed, suggesting that they did not create significant bias. Third, the internal consistency for the maternal HOME data was sub-optimal. Although internal consistency isn't always reported in developmental studies, psychometric research using the HOME (e.g., Bradley & Caldwell, 1979; Linver, Brooks-Gunn, & Cabrera, 2004) has previously reported levels of internal consistency similar to ours (i.e., .60 or less), suggesting that it may be inherent in the measure to some extent. In any case, our sensitivity analysis found that including and excluding the maternal HOME data did not alter the results, so this issue did not appear to introduce bias to the results. Fourth, our measures of maternal and paternal birth parent sociability were not correlated, so we could not include both in a latent construct without negatively impacting model fit. Thus, we standardized and combined the two measures to ensure we were representing the full “genetic load” inherited by the child. As reported in the Results section, usage of the maternal measure alone did not alter the findings, suggesting that our approach did not introduce bias. Finally, the children in our sample were primarily residing in middle class families, and it is unknown whether a similar pattern of findings would be identified in children residing in lower income families or high risk neighborhoods.

In conclusion, our analysis indicates that a high degree of sociability in birth parents can confer a degree of resilience to children, where the lack of sensitive, responsive parenting does not prevent a child from becoming socially competent with peers. Similarly, we found

that sensitive, responsive parenting can serve as a protective factor for genetically vulnerable children and encourage the development of social competence despite genetic risk. These results provide a needed degree of clarity regarding the relationship among genes, environment, and social competence during early childhood.

Our results also have implications for prevention. Genetic variation has been found to influence how individuals and families respond to parent-based prevention programs that target child externalizing behavior (Bakermans-Kranenburg, Van IJzendoorn, Pijlman, Mesman, & Juffer, 2008) and attention deficit/hyperactivity disorder (van den Hoofdakker et al., 2012). In addition, programs targeting behavior in older children have found evidence for genetic moderation of effects of improved parenting on adolescent substance use (Brody et al., 2014). Interestingly, genetic variation may also influence the responsiveness of individuals to one type of prevention programming as compared to others (Bauer et al., 2007). Overall, these findings, and ours, suggest that (1) genetic risk can be ameliorated by environmental factors, which in turn can be targeted by specific prevention programs; and, (2) exploring links among environmental and genetic influences on behavior can be a productive strategy for strengthening the effects of existing prevention programs by identifying particularly vulnerable and/or responsive populations. Future research could examine GxE effects on a wider variety of positive outcomes at different ages, which could not only add to our understanding of child development and but also highlight new opportunities for prevention and intervention.

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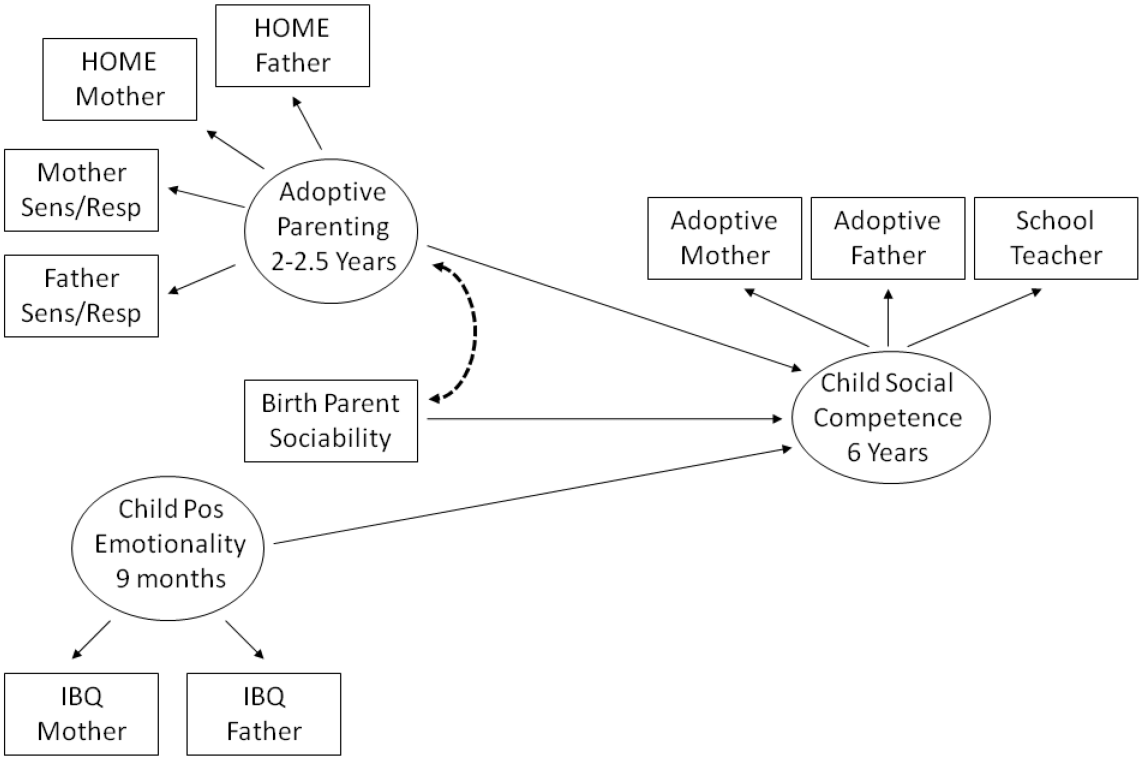

Figure 1.
Hypothesized model. Dashed line represents an interaction term.

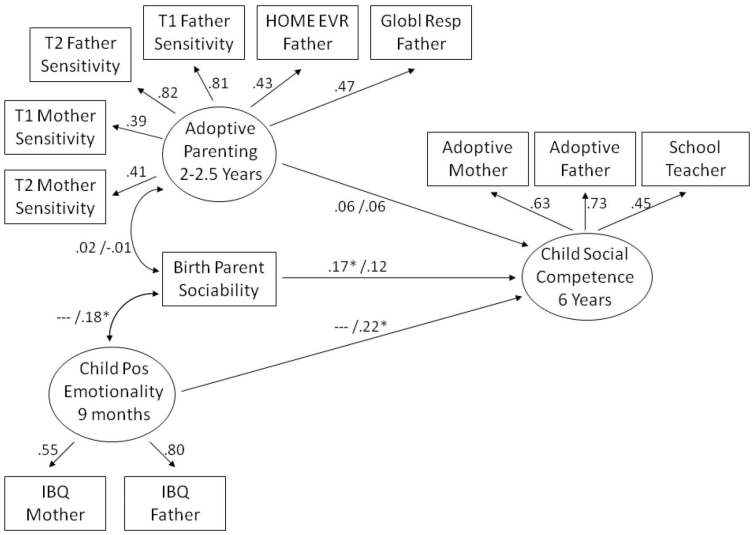

Figure 2.

Fitted model. T1 = Task 1 (teaching). T2 = Task 2 (clean-up). EVR = Emotional and Verbal Responsiveness subscale of HOME. Globl Resp = Global rating of responsiveness during parenting tasks. Betas for adoptive parenting and birth parent sociability predicting social competence are presented without/with the inclusion of child positive emotionality.

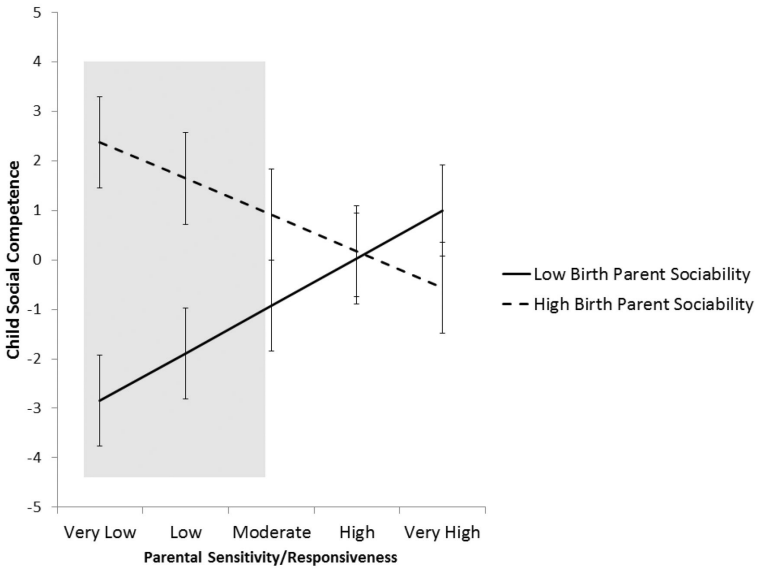

Figure 3.
Graph of interaction; shaded area represents region of significance.

Table 1

Correlations and Descriptive Data

	Adoptive Parenting								BP Sociability/Covariates			Child Social Competence		
	AM1	**AM2**	**AM3**	**AM4**	**AF1**	**AF2**	**AF3**	**AF4**	**BP Soc**	**AM PE**	**AF PE**	**Adp M**	**Adp F**	**Tchr**
AM1	–													
AM2	.29***	–												
AM3	.29***	.56***	–											
AM4	.32**	.32***	.24***	–										
AF1	.21**	.13*	.16**	.04	–									
AF2	.07	.32***	.32***	.09	.37***	–								
AF3	.02	.36***	.29***	.16*	.38***	.66***	–							
AF4	.08	.11*	.15*	.38***	.36***	.34***	.33***	–						
BP Soc	−.03	−.10	−.08	−.07	.02	−.04	−.06	.01	–					
AM PE	.04	−.03	.07	.10*	.04	−.14*	−.11	.04	.10	–				
AF PE	−.03	.00	.08	.08	.08	−.01	.06	.05	.14	.44***	–			
Adp M	−.07	−.03	.02	.09	−.10	.04	.02	−.05	.10	.15*	.14*	–		
Adp F	−.01	−.06	.02	−.07	−.04	.04	.01	−.07	.13	.13*	.20**	.45***	–	
Tchr	.09	.06	−.05	.03	.07	.10	.11	.04	.04	−.12	−.14	.29**	.29**	–
N	327	311	311	321	311	298	297	306	302	367	331	250	222	164
M	3.89	3.75	3.69	10.68	3.82	3.59	3.53	10.24	−.01	5.15	5.14	52.15	50.81	65.50
SD	.33	.49	.53	.82	.40	.57	.60	1.44	.95	.77	.79	8.54	8.89	12.78

Note. AMI = Adoptive Mother Responsiveness (global). AM2 = Adoptive Mother Sensitivity (clean-up task). AM3 = Adoptive Mother Sensitivity (teaching task). AM4 = Adoptive Mother Responsiveness (HOME). AF1 = Adoptive Father Responsiveness (global). AF2 = Adoptive Father Sensitivity (clean-up task). AF3 = Adoptive Father Sensitivity (teaching task). AF4 = Adoptive Father Responsiveness (HOME). BP Soc = Birth parent sociability; AM PE = Adoptive mother-report of positive emotionality; AF PE = Adoptive father-report of positive emotionality; Adp M = Adoptive mother report; Adp F = Adoptive father report; Tchr = Teacher report.

* $p < .05$;

** $p < .01$;

*** $p < .001$.