Published in final edited form as:

J Abnorm Child Psychol. 2012 August ; 40(6): 885–899. doi:10.1007/s10802-012-9618-7.

Differential Susceptibility Effects: The Interaction of Negative Emotionality and Sibling Relationship Quality on Childhood Internalizing Problems and Social Skills

Judith K. Morgan,

Department of Psychiatry, University of Pittsburgh, 219 Loeffler Building, Pittsburgh, PA 15232, USA

Daniel S. Shaw, and

Department of Psychology, University of Pittsburgh, Pittsburgh, PA, USA

Thomas M. Olino

Department of Psychiatry, University of Pittsburgh, 219 Loeffler Building, Pittsburgh, PA 15232, USA

Judith K. Morgan: morganjk@upmc.edu

Abstract

Whereas socialization influences in early childhood have been linked to children's emerging internalizing problems and prosocial behavior, relatively few studies have examined how NE might moderate such associations in both advantageous and maladaptive ways. Furthermore, more research is needed to evaluate the impact of sibling relationships as an influential socialization influence on these child outcomes. In the current study we examined how NE might differentially moderate the associations between quality of relationships with siblings and both internalizing problems and social skills at school entry. NE moderated the effects of positive and destructive sibling relationship quality on child internalizing problems. Specifically, for boys high on NE, more positive sibling relationship quality predicted fewer internalizing problems, but more destructive sibling conflict predicted more internalizing problems. NE also moderated the effects of destructive sibling conflict on child social skills. For boys high on NE, destructive sibling conflict predicted fewer social skills. Boys high on NE appear to show greater susceptibility to the effects of sibling socialization on child outcomes, relative to boys low on NE. The implications of these interactions are discussed with respect to differential susceptibility theory.

Keywords

NE; Sibling relationship quality; Internalizing problems; Social skills

Negative emotionality as a temperament trait has been demonstrated to heighten the association between negative socialization influences (e.g., harsh parenting) and important child outcomes, such as internalizing and externalizing problems (Eisenberg et al. 2009; Morris et al. 2002; van den Akker et al. 2010). Thus far, much of research has examined how negative emotionality may be problematic for child development, without evaluating how the temperament trait may also provide benefits to young children (Belsky and Pluess 2009). Also, whereas the role of parenting socialization has been explored in depth, the

impact of other socialization influences, such as sibling relationships have been evaluated less frequently (Pike et al. 2005). Early childhood represents a critical period in which siblings spend a significant amount of time with one another (Dunn 2002) and in which emotion regulatory processes and associated behavioral problems are developing (Cole et al. 2004). The current study evaluated how negative emotionality may moderate the effect of sibling relationship quality on internalizing problems and social skills in early childhood in both adaptive and maladaptive ways.

Since the pioneering work of Thomas and Chess (1977), researchers have investigated links between different dimensions of temperament in early childhood and risk of emerging problem behavior. One of the most heavily researched child temperament traits in early childhood that has emerged as relatively stable, somewhat heritable and predictive of problem behaviors is negative emotionality (van den Akker et al. 2010; Neppl et al. 2010; Rothbart and Bates 2006; Sanson et al. 2004). Negative emotionality (NE), also referred to as difficult temperament, distress proneness, or dysregulated temperament, has been described as proneness to sadness, anger, frustration, fear, or anxiety. Children characterized as being high on NE tend to display more intense emotion reactions in challenging situations, and cry and fuss more overall (Rothbart and Bates 2006; Thomas and Chess 1977).

Temperament as a Predictor of Later Child Adjustment

NE has emerged as a predictor of risk for various later emotional and behavioral problems (e.g., conduct problems), presumably due to its ability to shape how one adapts to environmental stressors (Rothbart and Bates 2006; Rubin et al. 2003; Sanson et al. 2004). It would be expected that children who show a greater propensity to sadness, anger, and frustration in early childhood would be at greater risk for developing depressive and anxiety symptoms in later childhood, as experience of these negative emotions represent important symptoms of internalizing problem behavior (Eisenberg et al. 2009; Feng et al. 2008). Indeed, a wealth of research has demonstrated a significant positive relation between NE and internalizing symptoms in children and adults (Chorpita 2002; Depauw et al. 2009; Lonigan et al. 2003; Mathiesen et al. 2009). However, other research examining the relation between NE and internalizing problem behavior has found no relation between NE and internalizing symptoms in young children (Hayden et al. 2006), leading some researchers to postulate an indirect or differential relation between NE and internalizing outcomes during childhood (Dougherty et al. 2010; Hyde et al. 2008). Specifically, it is possible that NE predicts internalizing outcomes in childhood or adulthood only for certain individuals (e.g., those also low on positive emotionality; Dougherty et al. 2010) or in combination with certain socialization influences (e.g., negative or controlling parenting; Morris et al. 2002).

Differential Susceptibility Theory

Several developmental models assert that temperament traits such as NE may moderate pathways from socialization influences in the environment to child outcomes (Sanson et al. 2004). The differential susceptibility model, posited by Belsky and Pluess (2009), suggests that the effects of the environment on child outcomes can be moderated by temperament in both advantageous and maladaptive ways, meaning those identified as being highly susceptible to negative environmental influences (i.e., children with high NE) may also receive the greatest benefit from positive environmental influences. This model goes beyond a diathesis-stress or dual risk model, which merely posits that stressful environments exacerbate risk for problematic behavioral outcomes for individuals with vulnerable traits (i.e. diathesis; Ellis et al. 2011). Instead as described by Ellis et al. (2011), the differential susceptibility model has a bright side, in that it evaluates and pinpoints the advantages of

certain traits in the context of positive, supportive environments. In doing this, researchers can highlight the need for, not only reducing the presence of negative environmental influences, but for promoting positive, supportive environments.

Some evidence already suggests that NE represents a vulnerability trait associated with increased susceptibility to social environments (Belsky and Pluess 2009; van Aken et al. 2007). Belsky and Pluess (2009) describe several studies that found that associations between parenting and later disruptive behavior were moderated by child NE during toddlerhood (e. g., Belsky et al. 1998). For example, van Aken et al. (2007) found that when compared to 16 to 19 month old boys with lower levels of NE, those with a more difficult temperament showed the largest increase in rates of externalizing problems across 6 months when mothers used highly controlling parenting techniques, but the smallest increase in externalizing behavior when mothers used sensitive parenting techniques.

Children high on NE may show greater susceptibility to the environment as a result of the capacity for negative emotions to differentially aid interpersonal relationships (e.g., increase energy to speak up for oneself when angry or seek social support when sad) or worsen interpersonal relationships (e.g., increase aggressive behavior when angry and withdraw socially when sad; Izard et al. 2002). In addition to behavioral-affective theories for NE as a susceptibility trait, findings from neurobiological and genetic studies indicate an association between NE and genes (i.e., 5-HTTLPR) that both show greater plasticity to environmental influences and positive associations with internalizing symptoms (Holmes and Hariri 2003; Pauli-Pott et al. 2009). Accordingly, NE may be a behavioral marker of genetic sensitivity to environmental influences.

The differential susceptibility model proposes that in addition to greater sensitivity to maladaptive environments and subsequent emerging behavior problems, susceptibility traits may show greater sensitivity to supportive environments and thus greater susceptibility to adaptive outcomes, such as pro-social skills and competencies. In other words, instead of predicting the absence of problem behaviors, susceptibility traits such as NE may be associated with a child's greater likelihood to thrive and adapt effectively in positive contexts (Belsky and Pluess 2009). Indeed, Ellis et al. (2011) outline four criteria for adequately assessing differential susceptibility, including examination of crossover interactions and simple slopes. The first criterion is a having no direct association between the susceptibility factor and the outcome variable. This expectation differentiates differential susceptibility from a diathesis-stress model, in which the susceptibility trait is presumed to be associated with the maladaptive outcome (and only exacerbated by the presence of negative socialization influences). Second, there should be a significant moderating effect or interaction (Aiken and West 1991) between the susceptibility factor (e.g., NE) and the socialization influence (e.g., sibling relationship quality). The third criterion is confirmation that the slope of the susceptibility group is significantly different from zero. This criterion provides evidence that the susceptibility trait is significantly associated with the outcome variable. Fourth, the slope of susceptibility group should be significantly steeper from the non-susceptibility group to provide evidence that the susceptibility group is more susceptible to socialization influences than the non-susceptibility group. Also differential susceptibility theorists suggest that researchers should evaluate children's susceptibility to both maladaptive outcomes and adaptive outcomes, as children outcomes should be influenced by both supportive and negative socialization influences (Belsky and Pluess 2009; Ellis et al. 2011).

Overall, temperament, particularly NE, has emerged as a moderately stable and heritable trait that is also influenced by environmental influences of socialization (van den Akker et al. 2010). More research on the role of NE in relation to adaptive outcomes is needed. For

example, child social skills are important as an adaptive outcome as they reflect children's emotion regulation abilities and positive involvement with peers and adults and may be greatly influenced by the positive or negative quality of socialization influences in the child's life. In this domain, understandably parenting has been the most widely studied socialization factor, with other socialization influences such as sibling relationships typically being ignored.

Sibling Relationships as Socialization Influences

Research has identified the sibling relationship as an important relationship in children's lives, above and beyond the parent-child relationship and other peer relationships (Bank et al. 2004). Sibling relationships share commonalities with the parent-child relationship (as siblings may provide guidance and modeling and take on a caregiver role) and with peer relationships (as siblings may engage in similar play interactions with each other as they do with peers). However, sibling relationships also differ from these relationships as they are characterized by higher levels of reciprocity, complementary behaviors, and uninhibited play and emotions than parent-child and peer relationships in the preschool years (Pike et al. 2005). The "sibling trainer" relationship perspective, posited by Patterson (1986) and adapted by McElwain and colleagues, describes the sibling relationship as a dynamic system between two "relative equals" who may be more likely to mimic each others' behavior when compared to a parent-child relationship or a relationship between less familiar peers (McElwain and Volling 2005). Indeed, research has indicated that even after accounting for the effects of parenting quality or peer relationships on child outcomes, sibling relationships greatly influence both child adaptive and maladaptive social outcomes (Stocker 1994).

Positive Sibling Relationships

In their distinct way, sibling relationships, particularly positive sibling relationships, influence children's emotional functioning by providing conjoint emotion regulation, offering experiences to develop prosocial skills, and providing a buffer for stress and negative emotions. In early childhood, sibling relationships may be the primary peer relationship and the starting ground for coping with stress and negative emotions, as interactions with siblings typically precede interactions with important similar-age peers (Dunn 2002). In fact, regulation of negative emotions is largely interpersonal in nature, particularly in the early years, with family members providing much of the regulation of infants' and toddlers' negative emotions (Cole et al. 2004). Clearly, the mother-child relationship is a primary area of development in these coping mechanisms, but the reciprocal nature of the sibling relationship may also provide a unique opportunity for children to learn self regulation. Siblings typically spend more time with each other during the preschool years engaging in reciprocal and interactive play than they do with parents or other peers (McElwain and Volling 2005). Indeed, preschool children have been found to show high levels of comforting behaviors to distressed younger siblings, even though they are less likely to exhibit such behaviors with peers (Rothbart and Bates 2006).

Some research groups have documented that sibling interactions provide opportunities for children to learn prosocial skills and can offer companionship and positive social experiences early in life (Pike et al. 2005). Better sibling relationship quality has been shown to buffer the effects of poor friend relationships on child problem behaviors in both preschool and school age children (McElwain and Volling 2005; Stocker 1994). Positive sibling relationships may also provide a buffer for stress and negative emotions through the presence of positive social experiences that tend to elicit positive emotions (Dennis et al. 2009; Fredrickson 2001). Additionally, positive sibling relationships may provide children with a broader range of positive emotion-enhancing skills that children can then apply to

challenging experiences, and may thus lessen the impact of negative emotions on children through the presence of positive emotion experiences.

Sibling Conflict

In a similar fashion, conflictual sibling relationships also greatly impact children's adaptive and maladaptive outcomes. Some evidence suggests that sibling conflict may be associated with increases in social competence across childhood and adulthood (Bedford et al. 2000). However, the degree to which sibling conflict is associated with beneficial outcomes appears to be related to the nature of sibling conflict (constructive vs. destructive). In contrast to more constructive sibling conflict, destructive sibling conflict, characterized by high levels of physical and verbal aggression, may play an important role in influencing the development of both externalizing and internalizing outcomes (Buist et al. 2011; Garcia et al. 2000; Kim et al. 2007). Garcia et al. (2000) found that destructive sibling conflict assessed at age 5 among a sample of low-income boys contributed independent variance to the prediction of children's conduct problems 1 year later according to parent and teacher reports, after accounting for earlier parenting and target child conduct problems. Destructive sibling conflict has also been associated with poor social functioning and internalizing problems in children and adolescents (Bank et al. 2004; Kim et al. 2007; Stocker et al. 2002). For example, Buist et al. (2011) found that high levels of negative affect between siblings was associated with internalizing problems 1 year later among a sample of early adolescents.

Hypotheses

Main Effects Hypotheses

We evaluated the contributions of NE and sibling relationship quality as predictors of internalizing problems and social skills in a sample of boys at socioeconomic risk for later behavioral problems. We hypothesized that positive sibling relationship quality would relate to less internalizing problems and better social skills. We also predicted that destructive sibling conflict would relate more internalizing problems and to poorer social skills. We predicted that NE would be unrelated to our outcomes of internalizing problems and social skills, after accounting for the effects of sibling socialization. While we explored the main effects of NE and sibling relationship quality on each of our outcomes, we were most interested in the effect of the interaction between these predictor variables on our outcome variables, adopting the adage "the main effects are in the interactions" (Ellis et al. 2011; pg. 13).

Interactive Effects Hypotheses

Based on criteria for differential susceptibility as proposed by Ellis et al. (2011), we hypothesized that (1) we would find a significant crossover interaction for NE and both positive sibling relationship and destructive sibling conflict on child internalizing problems and social skills. (2) We predicted that the slope for our susceptibility group (high NE) would be significantly different than zero for both models (positive sibling relationship and destructive sibling conflict). Specifically, for boys high on NE relative to boys low on NE, more destructive sibling conflict would be related to more internalizing problems and poorer social skills; however, more positive sibling relationship quality would be related to fewer internalizing problems and better social skills. (3) We expected that the slope for the susceptibility group (high NE) would be significantly steeper than the slope of the non-susceptibility group (low NE). Specifically, we expected to find no relationship between sibling socialization and our outcome variables for boys low on NE. (4) Despite prior literature identifying direct associations between NE and internalizing problems and social outcomes (Depauw et al. 2009; Mathiesen et al. 2009), we predicted that our susceptibility

trait (NE) would be unrelated to both internalizing problems and social skills, when accounting for sibling socialization, as required by differential susceptibility.

Method

Participants

Participants were 193 boys from an ongoing longitudinal project on vulnerability and resilience in boys from low-income families. Families were recruited to the study when boys were between the ages of 7 and 17 months of age from the Women, Infants, and Children (WIC) program in the greater Pittsburgh area. All participants were boys due to the longitudinal project's focus on antisocial behavior. The sample was 52% European-American, 38% African-American, and 10% were of other races/ethnicities (e.g., biracial, Hispanic). At the 18 month assessment, mothers ranged from 17 to 43 years old ($M=27.43$ years). In reporting relationship status, 66% of mothers were married or cohabitating, 29% were single, and 11% were separated, divorced, or widowed. Average family income was \$1,050 per month and the mean SES score was 26.7 using the Hollingshead Index, indicating working-class status (Hollingshead 1975). At the 5 year assessment, the closest age sibling was invited to participate in the study with the target child. When target boys were 5 years old, their participating siblings (53% male) ranged from 3 to 11 years old (mean age difference = 2.03 years) and 79% of the target boys were the younger sibling of the participating dyad ($N=153$), primarily because eligibility criteria required a sibling to be living in the home when target children were recruited in infancy.

Originally, 310 boys and their families were recruited to participate in the longitudinal project. Attrition tended to be modest at each wave, with some data available on 94% and 92% of families at the age 5 and 6 assessments, respectively. However, because of limitations in the availability of suitable videotapes for the sibling interaction at age 5 ($N=218$), and attrition between ages 1.5 and 6 (N reduced from 310 to 286), data on 193 families are reported on for the present study. There were no significant differences in mother's education level, family income, or boys' NE for children with data used in the current study compared to those without data due to attrition or unavailable sibling interaction data, child internalizing problems, or child social skills.

Procedure

For purposes of the current study, families participated in initial assessments when boys were 18 months and 24 months, with follow-ups at ages 5 and 6/7. At 18 months, boys were observed in the laboratory during tasks that assess NE relevant to temperament. At both 18 and 24 months, mothers reported on boys' NE using rating forms. At 5 years, each boy was observed in his home interacting with his closest age sibling in a semi-structured play activity. At age 6, the boys' mothers completed ratings of childhood behavior problems. At age 6 and/or 7, teachers completed ratings of children's social skills.

Measures

Negative Emotionality—At 18 months, boys were videotaped while participating in an approximately 60-min mother-child interaction series of tasks (for a more detailed description, see Owens et al. 1998). The tasks were designed to elicit a range of emotions, including negative emotions. The tasks included such procedures as a free-play period, a clean-up task, three teaching tasks, a no toys task (Smith and Pederson 1988), a high-chair task (Martin 1981) and following a break, the Strange Situation (Ainsworth and Wittig 1969). Independent observers made global ratings of the boys' amount of fussing and crying and global ratings of the boys' intensity of fussing and crying based on a 5-point Likert scale after watching the entire videotaped play observation for each infant (e.g., 1 = no fussing

and crying and 5 = almost or throughout the entire task; 1 = low intensity of crying and fussing and 5 = high intensity of crying and fussing, respectively). Interrater agreement (i.e., weighted kappas) for components of this videotaped play observation (e.g., amount of fussing/crying, intensity of fussing/crying) was calculated from 22 randomly selected cases and ranged from 0.77 to 0.96, with a mean of 0.84, indicating adequate reliability. The intraclass correlation for this variable was 0.91.

Mothers also rated boys' on their difficult behavior at 18 months and 24 months using the Infant Characteristics Questionnaire (ICQ; Bates et al. 1979). Sample items include "how easy or difficult is it to calm your baby when s/he gets upset" on a 7-point Likert scale (e.g., 1 = very easy and 7 = difficult). Internal consistency was high for ICQ at 18 months and 24 months ($\alpha=0.81$ and 0.82 , respectively).

NE was computed as the aggregate of the global ratings of amount of fussing and crying and of intensity of fussing and crying at 18 month observation, as well as maternal ratings of difficulty at 18 months and at 24 months ($\alpha=0.65$ for these four indicators). Each indicator was standardized prior to aggregation. A confirmatory factor analysis demonstrated good model fit ($\chi^2(1)=0.00$, CFI=1.00, RMSEA= 0.00) and adequate factor loadings (18 month intensity, $\beta=0.73$, $p<0.01$; 18 month frequency, $\beta=0.77$, $p<0.01$; 18 month parent report, $\beta=0.29$, $p<0.01$; 24 month parent report, $\beta=0.15$, $p<0.10$), when including residual correlation among indicators of parent report. Substantive findings were the same when analyses were conducted without the item with the weakest factor loading (24 month parent report of NE).

Sibling Relationship Quality—At age 5, each participant was videotaped playing with his closest age sibling at home. During this videotaped session, the examiner and mother completed a Q-sort task about parenting in the same room. An assistant sat nearby the siblings. Each sibling dyad was videotaped for 1 h while they played with one to three sets of interactive toys. The toys were (1) a castle with a shooting cannon and knights, (2) a Lion King set with moveable animal figures, and (3) Bendits bendable building materials. The children could continue to play with the same toy for the whole hour, but were prompted after 20 and 40 min to see if would prefer to switch to a new toy (Volling and Belsky 1992). Neither the examiner nor the assistant intervened in the siblings' play or interactions except to inform the mother if the child vacated the playing area or the child posed a threat to the video equipment. Mothers were involved with completing the Q-Sort but were informed that they may intervene in their children's behavior, if one or both of their children became dysregulated or engaged in dangerous behavior. As a result of mothers' involvement in other study materials (i.e., the Q-sort), mothers rarely intervened in the siblings' play.

Overall positive sibling relationship quality and overall destructive sibling conflict were coded globally from videotapes on a 5-point Likert scale using the Sibling Conflict Coding System (SCCS; Garcia et al. 2000, adapted from Volling and Belsky 1992). Positive sibling relationship was coded as playing, having fun together, smiling, laughing, listening, and supportive comments among both siblings. A high score on this scale indicated the presence of these positive behaviors. Destructive sibling conflict was also coded globally from these videotapes on a 5-point Likert scale using the SCCS. Destructive sibling conflict was coded by the presence of lengthy conflict sequences, physical aggression, and destructive behaviors (e.g., destruction of toys). These codes were used to differentiate destructive sibling conflict from more constructive conflict between siblings. As inter-rater agreement for global codes could not be achieved at a level of greater than 80% (in contrast to molecular codes that were also rated), consensus ratings were used to code global ratings of sibling relationship quality. To reach consensus, one coder presented her ratings to the group

of four coders, who would then watch 20 min of the tape together before reaching a group decision about the ratings for that tape (Garcia et al. 2000).

Internalizing Problems—Mothers completed the Child Behavior Checklist (CBCL; Achenbach 1992) when the boys were 6 years old. The CBCL is a widely used measure of childhood behavior problems. Mothers rate their children's behavior on a 3 point Likert scale (0 = not at all, 1 = somewhat or sometimes, 2 = a lot or most of the time). The broad-band Internalizing factor was used in the current study, for which internal consistency in the current sample was adequate ($\alpha=0.74$). Sample items include “nervous, high strung, tense” and “looks unhappy for no reason”.

Social Skills—Teachers completed the Social Skills Rating Scale (SSRS; Elliott et al. 1989) when the boys were 6 and/ or 7 years old. Of the 154 boys with SSRS data, 105 boys had teachers who completed the measure at both age 6 and 7. We created a latent variable using SEM to account for measurement of this variable at two time points. Additionally, in using SEM, models were estimated using full-information maximum likelihood estimation methods that permitted including all boys, regardless of missing data at one of the two time points (Kline 2005). The SSRS consists of three subscales: Cooperation, Assertiveness, and Self-Control. These subscales are rated on a 3 point Likert scale (0 = Never, 1 = Sometimes, 2 = Very Often). We used the composite score to measure the boys' overall adaptive social skills, for which internal consistency was high in this sample ($\alpha=0.90$). Sample items include “invites others to join activities” and “makes friends easily”.

Results

Preliminary Analyses

Table 1 presents the means and standard deviations and the intercorrelations for each of our variables. Equivalent normative scores (T-scores for CBCL; standard scores for SSRS) are also provided in parentheses in Table 1. Maternal ratings of child internalizing and teacher ratings of child social skills were significantly correlated ($r=-0.22$, $p<0.01$)

Data Analytic Strategy: Differential Susceptibility Model

Testing for differential susceptibility involves a series of two steps (Ellis et al. 2011). First, conventional moderator analyses should be conducted to test for a significant interaction between the susceptibility factor (i.e., NE) and environmental factor (i.e., sibling relationship quality; Aiken and West 1991). Second, follow-up analyses are required to determine whether the nature of the interaction meets the four criteria for a differential susceptibility effect. As previously stated, criteria include 1) a crossover interaction (in the context of both the presence of the positive environment factor and the presence of the negative environment factor) in which 2) the slope of individuals high on the susceptibility trait is significantly different than zero and 3) steeper than for those individuals low on the trait. Also, the susceptibility factor should 4) not be significantly related to the environmental factor (bi-directional effect) or to the outcome (dual risk). We followed the suggested steps in analyzing our data for a differential susceptibility effect.

Structural Equation Modeling

Structural Equation Modeling (SEM) was conducted using Mplus 5 (Muthen and Muthen 1998–2010) to analyze our hypothesized models. SEM is advantageous as it allows for simultaneous estimation of measurement reliability and structural relations. Additional strengths of SEM include its ability to provide estimates of model fit and its ability to handle missing data without the use of list-wise deletion used in other analytic strategies (Kline 2005).

We ran two SEM models, one in which positive sibling relationship quality was the environmental variable of interest and a second in which destructive sibling conflict was the environmental variable of interest. Both models were initially run including age difference between siblings and sex of sibling as control variables and moderators of NE and sibling relationship quality. Age difference between siblings and sex of sibling did not significantly moderate the effect of NE and sibling relationship quality on our outcome variables in either of our two sibling relationship quality models. As a result, they were removed as moderator variables to create more parsimonious models. Sex of sibling was included as a control variable in the models because of its significant relation with child social skills—boys with brothers had better social skills than boys with sisters ($F=9.13$; $p<0.01$).

For the first model, interaction terms were created by centering the predictor variables (i.e., NE, positive sibling relationship quality) and multiplying them together to create a two way interaction term (positive sibling relationship quality X NE; Aiken and West 1991). The interaction term for the second model (destructive sibling relationship quality X NE) was created in the same fashion. We created a latent variable for teacher-rated social skills to account for multiple measurement of this construct. This latent variable and mother-rated internalizing problems were entered simultaneously as outcome variables for both model 1 and model 2. This latent variables and mother-rated internalizing problems were entered simultaneously as outcome variables for both model 1 and model 2 (Figs. 1 and 2).

Positive Sibling Relationship

Thus, model 1 consisted of the following variables: sex of sibling, NE, positive sibling relationship quality, and the interaction of NE and positive sibling relationship quality. Model fit was good ($\chi^2=3.27$; CFI=1.00, RMSEA=0.00; Table 2).

Internalizing Symptoms—Higher levels of positive sibling relationship quality were related to fewer internalizing problems ($\beta=-0.15$, $t=-2.11$, $p<0.04$; partial $r(pr)=0.15$). The interaction between positive sibling relationship quality and NE in relation to child internalizing problems was significant ($\beta=-0.15$, $t=-2.18$, $p<0.03$; $pr=0.16$; Fig. 1).

Consistent with recommendations by Ellis et al. (2011), we conducted follow-up analyses of simple slopes by recomputing the SEM analyses, only using scores on the susceptibility variable (NE) that were either 1 SD above the mean or 1 SD below the mean. This modification was carried out to examine differences in slopes for individuals high versus low on the trait (i.e., NE; Ellis et al. 2011). These simple slope analyses revealed that for boys high on NE, higher positive sibling relationship quality was related to fewer internalizing problems ($\beta=-0.76$, $t=-2.66$, $p<0.01$; $pr=0.19$). Positive sibling relationship was unrelated to internalizing problems for boys low on NE ($\beta=0.46$, $t=1.59$, n.s). Regions of significance analyses were conducted to determine whether this interaction represented a crossover interaction (Bauer and Curran 2005), which indicated that differences existed between high NE and low NE children when positive sibling relationship quality was 2.77 SD below the mean. However, the region of significance for high positive sibling relationship quality was estimated at a value that did not exist on our positive sibling relationship quality scale. Figure 3 depicts the nature of these two interactions.

Social Skills—Neither NE, positive sibling relationship quality nor the interaction between these two variables predicted child social skills. As expected by preliminary analyses, sex of siblings was related to child social skills, such that boys with brothers had better social skills ($\beta=-0.31$, $t=-2.88$, $p<0.01$; $pr=0.20$).

Destructive Sibling Conflict

Model 2 consisted of the following variables: sex of sibling, NE, destructive sibling conflict, and the interaction of NE and destructive sibling conflict. Model fit was good ($\chi^2=0.93$; CFI=1.00, RMSEA=0.00; see Table 3; Fig. 2).

Internalizing Symptoms—Neither NE nor destructive sibling conflict was directly related to internalizing problems. The interaction between destructive sibling conflict and NE in relation to child internalizing problems was significant ($\beta=0.17$, $t=2.41$, $p<0.02$, $pr=0.17$). As expected based on correlational analyses, sex of sibling predicted child social skills, such that boys with brothers had better social skills ($\beta=-0.31$, $t=-2.88$, $p<0.01$; $pr=0.20$).

In follow-up simple slope analyses, higher levels of destructive sibling conflict were related to higher frequencies of internalizing problems for boys high on NE ($\beta=0.66$, $t=2.20$, $p<0.03$; $pr=0.16$). However, unexpectedly, for boys low on NE (1 SD below the mean), higher destructive sibling conflict predicted fewer internalizing problems ($\beta=-0.75$, $t=-2.48$, $p<0.02$; $pr=0.18$). Regions of significance analyses indicated that differences existed between high NE and low NE children when destructive sibling conflict was 0.51 SD below the mean and 1.56 SD above the mean. Figure 4 depicts the nature of these two interactions.

Social Skills—Neither NE nor destructive sibling conflict was directly related to child social skills. The interaction of NE and destructive sibling conflict predicted child social skills ($\beta=-0.22$, $t=-1.98$, $p<0.05$; $pr=0.14$). Again, sex of sibling predicted child social skills ($\beta=-0.29$, $t=-2.73$, $p<0.01$; $pr=0.19$). Boys with brothers were rated as having better social skills.

Simple slope analyses revealed that for boys high on NE, higher destructive sibling conflict related fewer social skills ($\beta=-0.99$, $t=-2.05$, $p<0.05$; $pr=0.15$; Fig. 5). Regions of significance analyses indicated that differences existed between high NE and low NE children when destructive sibling conflict was 1.10 SD below the mean and higher. The region of significance for low destructive sibling conflict was estimated at a value that did not exist on our destructive sibling conflict scale. Destructive sibling conflict did not relate to social skills for boys low on NE.

Discussion

Criteria for Differential Susceptibility

Our results clearly indicate a differential, moderating relation between sibling relationship quality and child internalizing problems and social skills, based on child NE. Our findings also meet three of the four criteria for differential susceptibility to internalizing problems: 1) high NE was unrelated to both child internalizing problems and social skills, 2) a significant crossover effect was evident for both positive sibling relationship and destructive sibling conflict on child internalizing problems, and 3) the slope for high NE was significantly different than zero in the environmental context of both positive sibling relationship quality and destructive sibling conflict on child internalizing problems.

The final criterion for differential susceptibility indicates that the slope of the susceptibility group be significantly steeper than the slope of the non-susceptibility group (Ellis et al. 2011). The slope of our susceptibility group (boys high on NE) was significantly steeper than the slope of our non-susceptibility group (boys low on NE) in the context of positive sibling relationship quality for child internalizing problems. However, we did not find that the slope of our susceptibility trait was significantly steeper than the slope for boys low on

NE for analyses of destructive sibling conflict on child internalizing problems. Instead, some evidence of a contrastive effect was found with boys low on NE paradoxically receiving some benefit from destructive sibling conflict. This contrastive effect was significant at existing values on our destructive sibling conflict scale, highlighting a contrastive, crossover effect of NE and destructive sibling conflict on child internalizing problems.

Evidence for differential susceptibility is bolstered by crossover effects on both adaptive and maladaptive outcomes (Ellis et al. 2011). We evaluated differential susceptibility effects on child social skills and internalizing problems. We did not find crossover effects of NE and sibling socialization on child social skills. NE and destructive sibling conflict interacted in predicting child social skills. The slope for boys high on NE for this effect was significantly different than zero and significantly steeper than the slope for boys low on NE. However, there was no significant interaction between NE and positive sibling relationship quality on child social skills. A susceptibility group must show greater sensitivity to a behavioral outcome in the context of both positive and negative environments to meet requirements for differential susceptibility (Ellis et al. 2011). Here, we find evidence that boys high on NE appear to be more susceptible to poor adaptive outcomes in the presence of negative environmental influences, but we do not find that boys high on NE show greater susceptibility to better adaptive outcomes in the presence of positive environmental influences.

In addition, tests of regions of significance provide information on discrete breakpoints in which our two environmental socialization variables affect child outcomes in the context of the interactive effect. This information is critical as it allows researchers and clinicians interested in intervention to understand what constitutes a highly destructive sibling relationship or a significantly low positive sibling relationship. Our tests of the regions of significance indicate that our measure of destructive sibling conflict and positive sibling relationship may not have been sufficiently variable to capture these true boundaries of significance. Another possibility is that there was no moderation at certain ends of the positive and destructive sibling scales (i.e., low destructive sibling and low positive sibling relationship quality). Although the estimated breakpoints of high destructive sibling conflict and high positive sibling relationship represented true values measured within our study, the estimated breakpoints for low destructive sibling conflict and low positive sibling relationship quality were values that did not exist on our measure (i.e., values below the minimum score of 1 on both measures). Additional research that includes measures of sibling relationship quality with a greater variability would be recommended. In addition, it would be helpful to know if the current pattern of results would be replicated among girls, and among samples of boys and girls from higher socioeconomic strata and living in nonurban communities (e.g., rural, suburban).

Taken together, our findings suggest partial support for a differential susceptibility effect of sibling socialization on internalizing problems as affected by high NE (i.e., meeting 3 of 4 criteria). Our findings extend the dual risk model to suggest that the effect of stress in the environment on a negative outcome is exacerbated by the presence of a vulnerability trait (e.g., as indicated by high NE exacerbating the effect of destructive sibling conflict on internalizing problems), and that there might be a “bright side” to having high levels of NE for boys with a highly positive sibling relationship. For boys low on NE, positive sibling relationship quality did not relate to internalizing problems, indicating that boys high on NE appear to receive the greatest benefit from positive sibling relationship quality. Even though we found some support for differential susceptibility, it should be acknowledged that not all four criteria were met. Differential susceptibility theory requires all four criteria be met (Belsky et al. 2007; Ellis et al. 2011). More research on NE and sibling socialization is required to evaluate fit with all four criteria.

We did not find evidence for differential susceptibility of NE and sibling socialization on child social skills. Evidence that boys high on NE show greater susceptibility to negative influences of destructive sibling conflict on child social skills supports both diathesis-stress and differential susceptibility models (Belsky et al. 2007). To extend diathesis-stress models to studying differential susceptibility, evidence that boys high on NE may be more highly susceptible to the positive influences of positive sibling relationship quality on child social skills is needed. More research is needed to evaluate the differential susceptibility effects of NE and sibling socialization on both adaptive and maladaptive child outcomes.

Negative Emotionality as a Risk Trait

Our findings support the notion that rather than NE representing a risk trait, it may represent a developmental susceptibility trait. In partial support of Belsky and Pluess' (2009) differential susceptibility hypothesis, we found the effect of sibling relationship quality at age 5 (both positive sibling relationship quality and destructive sibling conflict) on later internalizing problems to be moderated differentially by the presence of high NE. More positive sibling relationship quality related to poorer internalizing problems and more destructive sibling conflict related to more internalizing problems, but only for boys high on NE in toddlerhood. As expected and as would be suggested by differential susceptibility, for boys low on NE, we did not find that positive sibling relationship predicted child internalizing problems. Unexpectedly, more destructive sibling conflict predicted less internalizing problems in boys low on NE. In regard to child social skills, our adaptive outcome, higher levels of destructive sibling conflict predicted fewer child social skills for boys high on NE. For boys low on NE, destructive sibling conflict was unrelated to child social skills. We did not find that NE moderated the relation of positive sibling relationship quality on child social skills. Altogether, our findings provide partial support of a differential susceptibility effect of NE and sibling socialization on child adaptive and maladaptive outcomes.

Evolutionary theory suggests that adaptive and mal-adaptive environments have existed throughout the human experience and that susceptible individuals have been conditioned throughout natural selection to respond appropriately to both contexts (Bronfenbrenner 1993). NE appears to be one such susceptibility trait, in that children high on NE show differential responses to environmental influences relative to children low on this temperament trait, whether environmental influences are positive or negative. Some inferences about the mechanism driving the interaction between NE and environmental influences may be made based on previous findings indicating that siblings can provide children with prosocial and problematic examples of regulating emotions and coping with stress (Cole et al. 2004; Garcia et al. 2000; Pike et al. 2005). Boys high on NE may simply have more opportunities to use their positive interactions with siblings to help them regulate their intense negative emotions. Additionally, boys high on NE may show greater difficulty with internal regulation and thus may rely more heavily on external sources of regulation such as sibling support in comparison to boys low on NE. In contrast, boys low on NE may not be as affected by their sibling's behavior as they instead can utilize internal regulation processes to deal with their negative emotions, leading less susceptibility to sibling relationship quality for boys low on NE relative to boys high on NE. Indeed, in the current study boys high on NE and having more positive sibling relationships showed fewer internalizing problems than boys high on NE with less positive sibling relationships.

Another pathway to susceptibility is that propensity for negative emotions may differentially affect child behavior based on one's ability to effectively utilize the adaptive functions of negative emotions (Izard et al. 2002). In particular, based on socialization influences, boys may either learn to use anger to assertively solve a problem or sadness to seek social support. However, negative emotions that are dysregulated can exacerbate problems,

including using anger to aggressively solve a problem or sadness to withdraw from difficult social interactions (Izard et al. 2002). Positive socialization influences such as positive sibling relationships may increase the likelihood that boys learn to utilize their negative emotions more effectively, whereas negative socialization influences, including destructive sibling conflict, may contribute to boys being more susceptible for channeling their emotions in maladaptive ways.

In addition to the aforementioned behavioral and emotional theories suggesting greater susceptibility to environment via high NE, neurobiological research has indicated that NE appears to be linked to the short allele of the serotonin transporter gene (5-HTTLPR; Holmes and Hariri 2003). Studies on this gene indicate that the short (versus the long) allele is associated with greater susceptibility to environmental socialization on various outcomes, including depression, anxiety, and ADHD (Belsky et al. 2009). Accordingly, children high on NE may have a genetic loading for more biological sensitivity to both positive and negative socialization. As genetic data have recently been collected on the current sample, we intend to examine this possibility in future work.

Sibling Socialization: Mechanisms of Influence and Interactive Effects with Negative Emotionality

Based on behavioral, affective, and neurobiological theories, NE appears to be a plausible susceptibility trait that moderates the influence of socialization factors on child outcomes. In addition to other well-studied socialization influences (e.g. parents), the sibling relationship provides critical socialization in early childhood and its profound effect on child outcomes may be differentially determined by child NE. As indicated by previous literature, siblings spend significant periods of time with one another, particularly in the early childhood years (Dunn 2002). Siblings help one another in dynamic emotion regulatory strategies and may provide positive emotion experiences that can buffer the effects of negative events (Cole et al. 2004). Indeed consistent with previous literature linking positive sibling interactions with less behavior problems (McElwain and Volling 2005), higher levels of positive sibling relationship quality directly related to less internalizing problems in our study. Our finding may indicate that positive sibling socialization may decrease the likelihood of boys developing internalizing problems. Alternatively, boys with fewer internalizing problems may also just have more harmonious sibling relationships. As reflected by the adage “the main effects are in the interactions” (Ellis et al. 2011; pg. 13), our finding that NE moderated the relation of positive sibling relationship quality on internalizing problems may indicate that positive sibling socialization plays an important role in decreasing internalizing problems particularly for boys with intense negative emotions. Boys with high NE may benefit from positive sibling relationships partially because of siblings’ ability to help boys regulate their intense and frequent negative emotions and utilize them effectively to deal with difficult situations. This beneficial effect does not appear to pertain to boys low on NE, potentially because neurobiological differences in susceptibility and behavioral differences in frequency and intensity of negative emotions may dampen the positive impact of these sibling relationships.

Interestingly, the role of destructive sibling conflict on boys’ adaptive and maladaptive outcomes was not as clear. Much previous literature has associated destructive sibling conflict with negative child outcomes, including internalizing problems (Garcia et al. 2000; Stocker et al. 2002). Our evidence for a contrastive effect suggests that sibling socialization may serve different roles depending on boys’ temperament. Again, it appears that boys high on NE are more susceptible to the destructive quality of their sibling relationship relative to boys low on NE. Boys high on NE who experience more destructive sibling conflict also show more internalizing problems and fewer social skills. This interaction may be related to siblings providing and reinforcing maladaptive examples of emotion regulation strategies

more frequently. Neurobiological differences may also lead boys high on NE to be more sensitive to these maladaptive regulatory strategies.

On the other hand, boys low on NE appear to benefit from destructive sibling conflict. For boys low on NE, more challenging socialization influences (e.g., destructive sibling conflict) may optimize their development by providing them with early opportunities to learn how to deal with stressors. This possibility reflects an alternative interpretation of differential susceptibility theory, which posits that certain traits (e.g., high NE) render children more susceptible to both adaptive and maladaptive environments than children without those traits (i.e., low NE). However, other research has indicated that sibling temperament “fit” plays an important role in sibling relationship quality and developmental outcomes (Brody 1998). Also, it is possible that some sibling relationships may be high on both sibling conflict and positive relationship quality (and also low on both). Volatile sibling relationships (being high on both) and disengaged sibling relationships (being low on both) may “fit” well with some temperament traits and less so with others (e.g., low NE) leading to differential effects on child outcomes. Thus, certain types of sibling relationships may be differentially helpful for children depending on their temperament and its associated neurobiological/genetic loading. Further exploration of the associations between NE, sibling socialization, and child outcomes is needed in future research to clarify these effects (i.e., a more traditional differential susceptibility model vs. an alternative hypothesis). We focus here on how both positive and negative aspects of sibling socialization affect our susceptibility group (boys high on NE) in differential ways (i.e., both decreasing and increasing internalizing problems).

Differential Susceptibility: Different or Greater Susceptibility?

As alluded to above, another possibility is that susceptibility may vary depending on the susceptibility trait, such that boys high on NE may be just *differently* influenced (rather than more influenced) by socialization influences than boys low on NE. Indeed, one research study found evidence of greater susceptibility for boys low on NE (Kochanska et al. 2007). Compared to toddlers who were high on fear-proneness, low fear-prone 22 month-old toddlers showed a higher level of moral behavior at 33 months of age when mothers were low on control, but lower levels of moral behavior than other toddlers when mothers were high on control. This finding stands in contrast to other differential susceptibility findings for high NE (Belsky and Pluess 2009). Overall, the relation between negative emotionality, socialization influences, and child outcomes appears to be complex. Differential susceptibility appears to be one framework through which to understand the interactive effect of temperamental emotionality and socialization influences. However, previous literature and evidence from the current study indicate various possible ways that NE and socialization influences interact (e.g., greater susceptibility of high NE, differing susceptibility between high and low NE), and in the case of Kochanska et al. 2007, greater susceptibility of low NE. Nevertheless, understanding these differential findings is important for clarifying temperamental vulnerability to child adaptive and maladaptive outcomes.

It should be acknowledged that neither age difference between siblings nor sex of sibling significantly interacted with either of our sibling socialization variables or with NE in predicting internalizing problems or social skills. This finding suggests that the positive or negative nature of sibling relationships plays an important role on boys' outcomes, particularly internalizing problems, independent of sibling age or sex. Sex of sibling did however have a direct effect on child social skills. Unexpectedly, boys with a brother tend to show better social skills than boys with a sister. This finding may reflect that the sibling trainer model—in which siblings are viewed as “relative equals” who mimic each others' behavior—is particularly important in same-sex siblings (in this case—two brothers).

Regardless, having a brother or sister does not appear to interact with how sibling socialization and NE relate to child outcomes, the primary interest of this paper.

Strengths and Limitations

Strengths of the current study include the use of a prospective, longitudinal design to explore the potential moderating effect of toddlerhood NE on associations between sibling socialization and later indices of child adjustment. Furthermore, we used multiple informants (parent report, teacher report, independent observations) to strengthen our measurement and eliminate shared method variance, which included hour-long observationally-based assessments of both children's NE and sibling relationship quality.

Another strength is our focus on a differential susceptibility model. In past research, researchers have focused on the risk involved in exhibiting NE in toddlerhood. The differential susceptibility model represents a model that spreads the good news about susceptibility traits, that those who are at greatest risk for negative outcomes may also be the individuals with the greatest propensity to thrive depending on the context of the environment. This good news is not only beneficial in changing perception of vulnerability traits (e.g., toddlers high on NE viewed as problematic) but it also highlights the need to provide positive and supporting environments for these children (rather than just the absence of negative environments) so that these children can thrive and reach their fullest potential. More research is needed to replicate these differential susceptibility findings, but our findings represent a first step in acknowledging the powerful (and differential) impact of sibling socialization on boys high on NE.

As all of our participants were boys from primarily low-income and urban settings, we are unable to generalize our findings to girls, and boys and girls from higher socioeconomic strata and living in rural or suburban communities. It is possible that interactions between early NE and sibling relationship quality during the late preschool period affect internalizing problems and social skills differently in girls, and boys and girls from higher-SES backgrounds living in non-urban settings. Furthermore, only 17% of the boys in our study had clinically significant levels of internalizing problems at age 6 (i.e., scores of 60 or higher; Achenbach 1992) and 37% had social skills standard scores in the Below Average range (i.e., scores 2 SD below the mean of 100; Elliott et al. 1989). It is possible that our results would not generalize to a sample consisting of boys with more clinical levels of internalizing problems and poor social skills.

Other limitations include the use of observation of mother-child interactions as a measure of boys' NE. Mothers were required to be present in tasks that may be difficult or upsetting to 18 month olds because of ethical considerations. We assume that these tasks give us information on boys' NE but, while mothers were minimally involved in these tasks, it is possible that the boys' behavior may have also been influenced by their mothers' behaviors or parenting. Measurement of sibling interactions at only the 5 year assessment limited our ability to examine the stability of sibling relationship quality. Furthermore, measuring our independent variables at two distinct ages (18/24 months and 5 years old) limited our ability to look at their concurrent effect on one another. Based on previous literature, we assume that NE is moderately stable following toddlerhood (Neppl et al. 2010; Rothbart and Bates 2006); however, it is possible that boys' temperament changed from toddlerhood to 5 years of age.

Future Directions and Implications

Future directions should include evaluating how other and multiple socialization influences may be moderated by NE in predicting child outcomes, particularly internalizing problems

and social skills. Additionally, research is needed to replicate these findings to give additional evidence for this differential susceptibility effect. Research should also focus on which developmental periods appear to be most critical for the interaction of NE and socialization influences on these child outcomes (Holmes and Hariri 2003). Early childhood represents a critical period in which emotion regulatory strategies are developing and siblings spend significant periods of time with one another (Dunn 2002), however sibling socialization may also be crucial in late childhood and adolescence. In relation to early prevention and intervention programs, the current findings lend support for the importance of positive socialization experiences in the family, broadening this literature outside of parent influence to also include siblings, especially for boys high on NE in early childhood.

References

- Achenbach, TM. Manual for the child behavior checklist and revised child behavior profile. Burlington: University of Vermont, Department of Psychiatry; 1992.
- Aiken, LS.; West, SG. Multiple regression: Testing and interpreting interactions. Thousand Oaks, CA: 1991.
- Ainsworth, MDS.; Wittig, BA. Attachment and exploratory behavior of one-year-olds in a strange situation. In: Foss, BM., editor. Determinants of infant behavior IV. London: Methuen; 1969. p. 113-136.
- Bank L, Burraston B, Snyder J. Sibling conflict and ineffective parenting as predictors of adolescent boys' antisocial behavior and peer difficulties: additive and interactional effects. *Journal of Research on Adolescence*. 2004; 14:99-125.
- Bates JE, Freeland CA, Lounsbury ML. Measurement of infant difficultness. *Child Development*. 1979; 50:794-803. [PubMed: 498854]
- Bauer DJ, Curran PJ. Probing interactions in fixed and multilevel regression: inferential and graphical techniques. *Multivariate Behavioral Research*. 2005; 40:373-400.
- Bedford VH, Volling BL, Avioli PS. Positive consequences of sibling conflict in childhood and adulthood. *The International Journal of Aging and Human Development*. 2000; 51:53-69.
- Belsky J, Pluess M. Beyond diathesis stress: differential susceptibility to environmental influences. *Psychological Bulletin*. 2009; 135:885-908. [PubMed: 19883141]
- Belsky J, Hsieh KH, Crnic K. Mothering, fathering, and infant negativity as antecedents of boys' externalizing problems and inhibition at age 3 years: differential susceptibility to rearing experience? *Development and Psychopathology*. 1998; 10:301-319. [PubMed: 9635226]
- Belsky J, Bakermans-Kranenberg MJ, van IJzendoorn MH. For better and worse: differential susceptibility to environmental influences. *Current Directions in Psychological Science*. 2007; 16:300-304.
- Belsky J, Jonassaint C, Pluess M, Stanton M, Brummett B, Williams R. Vulnerability genes or plasticity genes? *Molecular Psychiatry*. 2009; 14:746-754. [PubMed: 19455150]
- Brody GH. Sibling relationship quality: its causes and consequences. *Annual Review of Psychology*. 1998; 49:1-24.
- Bronfenbrenner, U. The ecology of cognitive development. In: Wozniak, R.; Fischer, K., editors. *Scientific environments*. Hillsdale: Erlbaum; 1993. p. 3-44.
- Buist KL, Dekovic M, Gerris JRM. Dyadic family relationships and adolescent internalizing and externalizing problem behavior: effects of positive and negative affect. *Family Science*. 2011; 2:34-42.
- Chorpita BF. The tripartite model and dimensions of anxiety and depression: an examination of structure in a large school sample. *Journal of Abnormal Child Psychology*. 2002; 30:177-190. [PubMed: 12002397]
- Cole P, Martin SE, Dennis TA. Emotion regulation as a scientific construct: methodological challenges and directions for child development research. *Child Development*. 2004; 75:317-333. [PubMed: 15056186]

- Dennis TA, Cole PM, Wiggins CN, Cohen LH, Zalewski M. The functional organization of preschool-age children's emotion expressions and actions in challenging situations. *Emotion*. 2009; 9:520–530. [PubMed: 19653775]
- DePauw SSW, Mervielde L, Van Leeuwen KG. How are traits related to problem behavior in preschoolers? Similarities and contrasts between temperament and personality. *Journal of Abnormal Child Psychology*. 2009; 37:309–325. [PubMed: 19165590]
- Dougherty LR, Klein DN, Durbin CE, Hayden EP, Olino TM. Temperamental positive and negative emotionality and children's depressive symptoms: a longitudinal prospective study from age three to age ten. *Journal of Social and Clinical Psychology*. 2010; 29:462–488.
- Dunn, J. Sibling relationships. In: Smith, PK.; Hart, CH., editors. *Blackwell handbook of childhood social development*. Malden: Blackwell Publishing; 2002. p. 223–237.
- Eisenberg N, Valiente C, Spinrad TL, Cumberland A, Liew J, Reiser M, Zhou Q, Losoya SH. Longitudinal relations of children's effortful control, impulsivity, and negative emotionality to their externalizing, internalizing, and co-occurring behavior problems. *Developmental Psychology*. 2009; 45:988–1008. [PubMed: 19586175]
- Elliott SN, Barnard J, Gresham FM. Preschoolers' social behavior: teachers' and parents' assessments. *Journal of Psychoeducational Assessment*. 1989; 7:223–234.
- Ellis BJ, Boyce WT, Belsky J, Bakermans-Kranenburg MJ, van IZendoorn MH. Differential susceptibility to the environment: an evolutionary-neurodevelopmental theory. *Development and Psychopathology*. 2011; 23:7–28. [PubMed: 21262036]
- Feng X, Shaw DS, Silk JS. Developmental trajectories of anxiety symptoms among boys across early and middle childhood. *Journal of Abnormal Psychology*. 2008; 117:32–47. [PubMed: 18266484]
- Fredrickson BL. The role of positive emotion in positive psychology: the broaden-and-build theory of positive emotions. *American Psychologist*. 2001; 56:218–226. [PubMed: 11315248]
- Garcia MM, Shaw DS, Winslow EB, Yaggi KE. Destructive sibling conflict and the development of conduct problems in young boys. *Developmental Psychology*. 2000; 36:44–53. [PubMed: 10645743]
- Hayden EP, Klein D, Durbin CE, Olino TM. Positive emotionality at age 3 predicts cognitive styles in 7-year-old children. *Development and Psychopathology*. 2006; 18:409–423. [PubMed: 16600061]
- Hollingshead, AB. Unpublished manuscript. Yale University, Department of Sociology; 1975. Four factor index of social status.
- Holmes A, Hariri AR. The serotonin transporter gene-linked polymorphism and negative emotionality: placing single gene effects in the context of genetic background and environment. *Genes, Brain, & Behavior*. 2003; 2:332–335.
- Hyde JS, Mezulis AH, Abramson LY. The ABCs of depression: integrating affective, biological, and cognitive models to explain the emergence of the gender difference in depression. *Psychological Review*. 2008; 115:291–313. [PubMed: 18426291]
- Izard CE, Fine S, Mostow A, Trentacosta C, Campbell J. Emotion processes in normal and abnormal development and preventive intervention. *Development and Psychopathology*. 2002; 14:761–787. [PubMed: 12549703]
- Kim J, McHale SM, Crouter AC, Osgood DW. Longitudinal linkages between sibling relationships and adjustment from middle childhood through adolescence. *Developmental Psychology*. 2007; 43:960–973. [PubMed: 17605528]
- Kline, RB. *Principles and practice of structural equation modeling*. New York: Guilford Press; 2005.
- Kochanska G, Aksan N, Joy ME. Children's fearfulness as a moderator of parenting in early socialization: two longitudinal studies. *Developmental Psychology*. 2007; 43:222–237. [PubMed: 17201521]
- Lonigan CJ, Phillips BM, Hooe ES. Relations of positive and negative affectivity to anxiety and depression in children: evidence from a latent variable longitudinal study. *Journal of Consulting and Clinical Psychology*. 2003; 71:465–481. [PubMed: 12795571]
- Martin J. A longitudinal study of the consequences of early mother-infant interaction: a microanalytic approach. *Monographs for the Society of Research in Child Development*. 1981; 46:59.

- Mathiesen KS, Sanson A, Stoolmiller M, Karevold E. The nature and predictors of undercontrolled and internalizing problem trajectories across early childhood. *Journal of Abnormal Child Psychology*. 2009; 37:209–222. [PubMed: 18766436]
- McElwain NL, Volling BL. Preschool children's interactions with friends and older siblings: relationship specificity and joint contributions to problem behavior. *Journal of Family Psychology*. 2005; 19:486–496. [PubMed: 16402863]
- Morris AS, Silk JS, Steinberg L, Sessa FM, Avenevoli S, Essex MJ. Temperamental vulnerability and negative parenting as interacting predictors of child adjustment. *Journal of Marriage and Family*. 2002; 64:461–471.
- Muthen, L.; Muthen, B. *Mplus: User's guide 6.0*. Los Angeles: Muthen & Muthen; 1998–2010.
- Neppel TK, Donnellan MB, Scaramella LV, Widaman KF, Spilman SK, Ontai LL, Conger RD. Differential stability of temperament and personality from toddlerhood to middle childhood. *Journal of Research in Personality*. 2010; 44:386–396. [PubMed: 20634996]
- Owens EB, Shaw DS, Vondra JI. Relations between infant irritability and maternal responsiveness in low-income families. *Infant Behavior and Development*. 1998; 21:761–778.
- Patterson, GR. The contribution of siblings to training for fighting: A microsocial analysis. In: Olweus, D.; Block, J.; Radke-Yarrow, M., editors. *Development of antisocial and prosocial behavior: Research, theories, and issues*. Orlando: Academic; 1986. p. 235–261.
- Pauli-Pott U, Friedl S, Hinney A, Hebebrand J. Serotonin transporter gene polymorphism (5-HTTLPR), environmental conditions, and developing negative emotionality and fear in early childhood. *Biological Psychiatry*. 2009; 116:503–512.
- Pike A, Coldwell J, Dunn JF. Sibling relationships in early/middle childhood: links with individual adjustment. *Journal of Family Psychology*. 2005; 19:523–532. [PubMed: 16402867]
- Rothbart, M.; Bates, J. Temperament. In: Eisenberg, N.; Damon, W.; Richard, LM., editors. *Handbook of child psychology: Vol. 3, Social, emotional, personality development*. 6. Hoboken: Wiley; 2006. p. 99–166.
- Rubin KH, Burgess KB, Dwyer KM, Hastings PD. Predicting preschoolers' externalizing behaviors from toddler temperament, conflict, and maternal negativity. *Developmental Psychology*. 2003; 39:164–176. [PubMed: 12518817]
- Sanson A, Hemphill SA, Smart D. Connections between temperament and social development: a review. *Social Development*. 2004; 13:142–170.
- Smith PB, Pederson DR. Maternal sensitivity and patterns of infant-mother attachment. *Child Development*. 1988; 59:1097–1101. [PubMed: 3168617]
- Stocker CM. Children's perceptions of relationships with siblings, friends, and mothers: compensatory processes and links with adjustment. *Journal of Child Psychology and Psychiatry*. 1994; 35:1447–1458. [PubMed: 7868639]
- Stocker CM, Burwell RA, Briggs ML. Sibling conflict in middle childhood predicts children's adjustment in early adolescence. *Journal of Family Psychology*. 2002; 16:50–57. [PubMed: 11915410]
- Thomas, A.; Chess, S. *Temperament and development*. Oxford: Brunner/Mazel; 1977.
- van Aken C, Junger M, Verhoeven M, van Aken MAG, Dekovic M. The interactive effects of temperament and maternal parenting on toddlers' externalizing behaviors. *Infant and Child Development*. 2007; 16:553–572.
- van den Akker AL, Dekovic M, Prinzie P, Asscher JJ. Toddlers' temperament profiles: stability and relations to negative and positive parenting. *Journal of Abnormal Child Psychology*. 2010; 38:485–495. [PubMed: 20058064]
- Volling BL, Belsky J. The contribution of mother-child and father-child relationships to the quality of sibling interaction: a longitudinal study. *Child Development*. 1992; 63:1209–1222. [PubMed: 1446550]

Fig 1. Differential susceptibility effects of NE and positive sibling relationship quality on child internalizing problems and social skills. Note. $R^2=0.06$ for CBCL Internalizing Problems. $R^2= 0.15$ for SSRS Social Skills

Fig 2.

Differential susceptibility effects of NE and destructive sibling conflict on child internalizing problems and social skills. Note. $R^2=0.04$ for CBCL Internalizing Problems. $R^2=0.16$ for SSRS Social Skills

Fig 3.
Interaction of NE and positive sibling relationship on CBCL internalizing problems

Fig 4.
Interaction of NE and destructive sibling conflict on CBCL internalizing problems

Fig 5.

Interaction of NE and destructive sibling conflict on SSRS social skills. Note. Social skills measured using a latent variable. Scale of this latent variable is different than scale of observed variables

Means, standard deviations, and intercorrelations among age difference, sex of sibling, positive sibling relationship, NE, internalizing problems and social skills

Table 1

Variable	M	SD	R	N	1	2	3	4	5	6	7
1. Age difference	2.03	2.01	-2.00-6.00	193	-	-	-	-	-	-	-
2. Sex of sibling	-	-	-	193	0.05	-	-	-	-	-	-
3. Positive sibling	2.72	0.965	1.00-4.00	193	0.18*	-0.09	-	-	-	-	-
4. Destructive sibling	2.15	1.04	1.00-4.00	193	-0.18*	0.03	-0.27**	-	-	-	-
5. NE	0.01	2.76	-7.37-9.07	183	0.00	0.04	0.08	-0.05	-	-	-
6. Internalizing problems	5.61 (50.41)	4.82 (9.32)	0.00-24.00 (34-75)	191	-0.10	-0.07	-0.10	-0.00	-0.05	-	-
7. Social skills (age 6)	36.57 (78.02)	11.45 (14.42)	3.00-57.00 (43-108)	141	-0.07	-0.22**	0.10	-0.05	0.04	-0.18*	-
8. Social skills (age 7)	38.17 (79.84)	10.45 (13.68)	13.00-58.00 (52-109)	123	-0.09	-0.21**	0.02	-0.03	-0.01	-0.21*	0.40**

Normative data (T-scores for Internalizing Problems, Standard Scores for Social Skills) are presented in parentheses

Table 2

Positive sibling relationship on internalizing problems and social skills

Standardized model effects	β	t	p
CBCL internalizing problems ($N=187$)			
Sex of siblings	-0.08	-1.06	0.29
NE	0.09	1.31	0.19
Positive sibling relationship	-0.15	-2.11	0.04
NE $\times$ Positive sibling relationship	-0.15	-2.19	0.03
SSRS social skills ($N=187$)			
Sex of sibling	-0.31	-2.88	0.00
NE	0.01	0.09	0.93
Positive sibling relationship	0.10	0.96	0.34
NE $\times$ Positive sibling relationship	-0.20	-1.81	0.08

CFI=1.00; RMSEA=0.00

Table 3

Destructive sibling conflict on internalizing problems and social skills

Standardized model effects	β	t	p
CBCL internalizing problems ($N=187$)			
Sex of siblings	-0.07	-1.01	0.31
NE	0.08	1.07	0.28
Destructive sibling conflict	-0.04	-0.62	0.53
NE $\times$ Destructive sibling conflict	0.17	2.41	0.02
SSRS social skills ($N=187$)			
Sex of sibling	-0.29	-2.73	0.01
NE	0.00	0.03	0.98
Destructive sibling conflict	-0.07	-0.61	0.55
NE $\times$ Destructive sibling conflict	-0.22	-1.98	0.05

CFI=1.00; RMSEA=0.00