

**ORIGINAL ARTICLE**

# Diathesis stress or differential susceptibility? testing longitudinal associations between parenting, temperament, and children's problem behavior

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**Abstract**

In this study we investigated longitudinal associations among parenting, children's temperamental negative affectivity, and internalizing and externalizing behavior. Second, we tested whether findings confirmed the diathesis-stress model or differential susceptibility theory when conducting stringent interaction tests. The sample included 129 children and their families. Parenting quality (age 5) was measured by parent-child interaction observations. Parents evaluated child negative affectivity (age 7) and teachers reported on problem behavior (age 12). Multiple regression analyses revealed an interaction effect of negative affectivity and parenting on externalizing behavior. Visual inspection suggested 'for better and for worse' effects of parenting for children with negative affectivity. However, more stringent tests failed to show convincing evidence for differential susceptibility theory. For internalizing behavior, negative affectivity may render children vulnerable regardless of parenting. Our results point at the importance of further testing interaction effects to distinguish between differential susceptibility theory and the diathesis-stress model.

**KEYWORDS**

diathesis stress model, differential susceptibility theory, externalizing behavior, internalizing, parenting, temperament

**1 | INTRODUCTION**

In a developmental-ecological framework, the development of children's problem behavior can be seen as resulting from complex interactions among child personal, familial, and extra-familial factors (e. g., Loeber, Burke, & Pardini, 2009). Considerable empirical evidence has been produced over the past several decades showing that inadequate

parenting quality (i. e., parenting characterized by autonomy-suppressing harsh, inconsistent control, and a lack of parental warmth) is an important predictor of onset and maintenance of child problem behavior (e. g., Grusec, 2011). However, not all children are equally affected by the parenting quality. In the research literature on individual factors that moderate the impact of parenting on child development, there are two dominant models explaining differences to environmental influences.

The first model, the *diathesis-stress* model (Zuckerman, 1999), suggests that some individuals possess characteristics that make them more vulnerable to environmental stressors. Negative experiences, such as low quality parenting, are most likely to negatively impact the development of individuals who carry vulnerability factors. These vulnerabilities can be behavioral in character, such as high temperamental negative affectivity, or physiological or genetic. The assumption is that a stressor can activate the diathesis, or vulnerability factor, and may transform it into psychopathology (Monroe & Simons, 1991). The second model of individual differences in sensitivity to environmental influences, the *differential susceptibility* model, grounded in evolutionary theories, suggests that individuals who are most vulnerable to environmental stressors may also be the ones who benefit most from environmental support. The same children who are most affected by negative experiences are also most likely to benefit from high parenting quality ('for better and for worse'; Belsky, Bakermans-Kranenburg, & van IJzendoorn, 2007). So, in differential susceptibility theory, children are not seen as vulnerable to environmental exposure, but rather as developmentally plastic or susceptible (Belsky & Pluess, 2009). In other words, if the diathesis-stress model is right, the children with the diathesis are particularly vulnerable to negative experiences. With positive experiences, the outcome for them might be average and these children with the diathesis rise to the level of the children without the diathesis. In contrast, if the differential susceptibility theory is right, the children with the susceptibility will have poor outcomes with negative experiences, but actually will have better outcomes with positive experiences than the children without the susceptibility.

A recent meta-analysis (Slagt, Dubas, Dekovic, & van Aken, 2016), showed that many studies, especially in the last 5 years, found evidence for the differential susceptibility model. In these studies child temperament—biologically based and relatively stable individual differences in emotional and behavioral responses (Rothbart & Bates, 2006)—is seen as a potential susceptibility marker. Specific temperament traits not only placed children at risk for negative outcomes when confronted with poor parenting, but also enhanced adaptation in positive parenting circumstances. Although thus the evidence for differential susceptibility theory seems to be growing (e. g., Belsky & Pluess, 2013; Kochanska, Kim, Barry, & Philibert, 2011), there are still some gaps in the literature.

First, most of the studies on differential susceptibility focused on early childhood and included relatively small time intervals between assessments of parenting, child temperament, and child outcomes. In this study we investigated whether the longitudinal associations, covering the period from middle childhood to early adolescence, between parenting and children's problem behavior were moderated by temperamental negative affectivity. The transition from middle childhood to adolescence is an important period with many changes in development (Connolly, Paikoff, & Buchanan, 1996). It can be seen as a developmental risk point with significant increases in problem behavior (e. g., Walker, Colvin, & Ramsey, 1995). Although temperament is seen as a relatively stable trait (Rhee et al., 2012, Rothbart & Bates, 2006), it is also shaped by the environment (Pluess, Belsky, Way, & Taylor, 2010). When children grow older, temperament becomes increasingly fine-tuned (Hall & Perona, 2012). Especially those children who continue to show high negative affectivity, and for whom it becomes an increasingly stable trait, might be less likely to profit from a positive environment. Negative affectivity at older ages might thus become a vulnerability factor (Ormel et al., 2013). So it is important to also examine associations between parenting and temperament measured at later ages because it gives us more insight into whether temperament is a marker of susceptibility regardless of when it is assessed or whether temperament evolves from a susceptibility marker into a vulnerability marker when the child grows older.

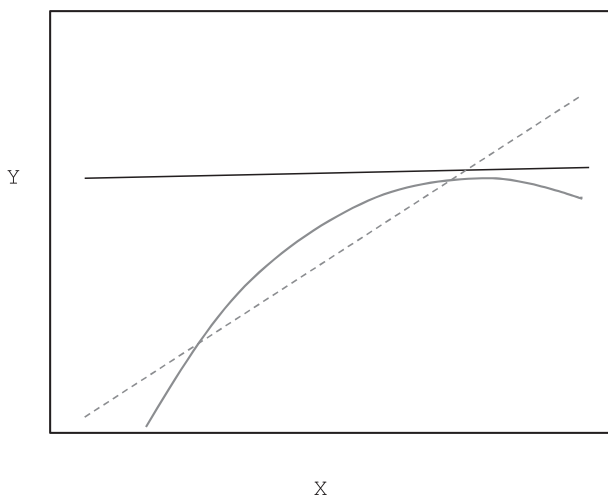
Second, we included both internalizing and externalizing behavior as outcomes. Although most studies on diathesis stress and differential susceptibility focused on externalizing behavior (Belsky & Pluess, 2009), and more recently on internalizing behavior, only a few studies included both internalizing and externalizing behavior (Poehlmann et al., 2012). Because internalizing and externalizing behavior may likely be the result of different antecedents (e. g., different neurobiological systems that are sensitive to different environmental inputs), it is important to distinguish between

these two constructs as domain specific effects may occur (for a review, see Ellis, Boyce, Belsky, Bakermans-Kranenburg, & van IJzendoorn, 2011).

Third, recently, it has been discussed whether evidence for differential susceptibility so far holds up when new methodological guidelines to differentiate differential susceptibility from diathesis-stress are followed (Kochanska et al., 2011; Roisman et al., 2012). Many studies (e. g., Pitzer, Jennen-Steinmetz, Esser, Schmidt, & Laucht, 2011, Poehlmann et al., 2012; Ramchandani, van IJzendoorn, & Bakermans-Kranenburg, 2010) based their conclusions on plots of interactions and simple slope analyses. Some studies find that negative affectivity operates in a way consistent with diathesis-stress (e. g., Kochanska & Kim, 2013) and some with differential-susceptibility theory (e. g., Lengua, 2008; Poehlmann et al., 2012; Ramchandani et al., 2010). This inconsistency could, among others, be due to different interpretations when visually inspecting interaction plots.

To distinguish diathesis-stress from differential susceptibility, several methodological issues have been suggested that should be addressed. Kochanska and colleagues (2011) suggested testing interactions with the analysis of *regions of significance* (Aiken & West, 1991; Preacher, Curran, & Bauer, 2006). Through this method, upper and lower bounds (i. e., the for-better and for-worse sides of the differential-susceptibility hypothesis) of the regions of significance are tested, that is, specific values of the independent variable (parenting) below which and above which the regression lines for different children (high or low on negative affectivity) differ significantly in terms of specific outcomes (internalizing and externalizing behavior). In other words, the analysis of *regions of significance* identifies whether children high in negative affectivity do as well, but not better, in positive parenting circumstances compared to children scoring low on negative affectivity (providing evidence for the diathesis stress model), or whether these children with high levels of negative affectivity do better than children with lower negative affectivity (providing evidence for the differential susceptibility theory).

Roisman and colleagues (2012) also have formulated several guidelines to better differentiate diathesis-stress from differential susceptibility. As apparent differential susceptibility effects can be 'an artifact of imposing a linear predictor model on a nonlinear diathesis-stress phenomenon' (Roisman et al., 2012, p. 308), nonlinear effects should be tested. For example, children high on negative affectivity might do as well as children low on negative affectivity when parenting quality is high, but they might do increasingly worse when parenting quality becomes lower. This interaction effect manifests itself as a flat line for the children low on negative affectivity, and a curved line for the children high on negative affectivity not crossing the flat line of the children low on negative affectivity [see Figure 1, an adapted version of the figure in Roisman et al. (2012, p. 398)]. However, if only a linear regression line were plotted for the children high



**FIGURE 1** Adapted version of the Roisman et al. (2012) figure (p. 398): 'Nonlinear relations masquerading as differential susceptibility'. X = predictor variable (i. e., parenting); Y = outcome variable (i. e., child problem behavior). Different lines indicated high and low levels of the moderator (i. e., negative affectivity). Solid lines = nonlinear model; dotted lines = linear model

on negative affectivity, this regression line would cross the flat line of the children low on negative affectivity, and incorrectly suggest evidence for differential susceptibility (for a figure of this effect, see Roisman et al., 2012, p. 398). In other words, one might observe a differential susceptibility effect that is not there.

Additionally, Roisman and colleagues (2012) recommended calculating the *proportion of interaction index*, that reflects the proportion of the total area of an interaction plot that is uniquely attributable to differential susceptibility, and the *proportion affected (PA)*, which represents the proportion of people in the sample who fall above the crossover point (i. e., proportion of sample in the for-better condition).

In this study, we used all the above approaches to test whether the interactions found indeed supported differential susceptibility rather than diathesis-stress. In sum, the first aim of this study was to investigate whether the longitudinal associations between parenting and children's internalizing and externalizing behavior were moderated by temperamental negative affectivity. The second aim of this study was, by including formal and more stringent tests of moderation effects, including the regions of significance approach (Kochanska et al., 2011) and the recently suggested guidelines for evaluating interaction effects (Roisman et al., 2012), to determine whether there was evidence for the diathesis-stress model or differential susceptibility theory.

With respect to our first aim, we hypothesized that children with higher scores on negative affectivity would show more internalizing and externalizing behaviors when confronted with low quality parenting whereas children with lower scores on negative affectivity would be less affected by parenting. With respect to our second aim, we expected that children would vary in their response to parenting depending on their temperament, with children high on negative affectivity being more affected by both positive and negative parenting. Although recent studies showed that the differential effects often do not hold when tested in a more rigorous way (Roisman et al., 2012), based on a large body of literature finding strong evidence for interaction effects between temperament and parenting on child behavior (see Belsky & Pluess, 2009 for a review), we expected to find individual differences in response to the environment in line with differential susceptibility theory.

## 2 | METHOD

### 2.1 | Participants

The participants of the current study were recruited as part of the Nijmegen Longitudinal Study. This longitudinal study on infant and child development started in 1998 with a community-based sample of 129 children at 15 months of age (Van Bakel & Riksen-Walraven, 2002) and was regularly followed since then. At 15 months, children and their primary caregivers were recruited on the basis of records from local health-care centers in a middle-sized city in the East of The Netherlands. During nine consecutive months, all families in this city with a 15-month-old baby ( $n = 639$ ) from various socioeconomic backgrounds were sent an invitation to participate in the study that aimed to gain more insight into children's development in the first years of life. Families had to meet two eligibility criteria, that is, sufficient fluency in Dutch and no serious child health problems. A total of 174 families were willing to participate, of which 129 families (the maximum attainable given time and resources available for the project) were randomly selected for participation. At each wave, informed consent for the data collection was obtained from parents. When parents were willing to participate, teachers were recruited with a letter explaining the study and a follow-up phone call. Teacher informed consent was obtained following school policies.

The sample included 123 two-parent families and 6 single-parent families. In 3 families, the father was the primary caregiver of the child. No significant differences in scores on parenting ( $t = -1.18, p = .24$ ), negative affectivity ( $t = .09, p = .93$ ), internalizing ( $t = .66, p = .51$ ), or externalizing behavior ( $t = .79, p = .43$ ) were found between families with fathers as primary caregivers versus families with mothers as primary caregivers. The percentages of single parents and of fathers acting as primary caregivers were representative of families in The Netherlands with children in this age group. In the sample, 38% of the primary caregivers were homemakers, and only 4% worked out of the home for more than 32 hr a week. Most primary caregivers worked part-time (58%) with a mean of 24.08 hr ( $SD = 7.00$ ) a week. Their ages ranged from 22 to 47 years ( $M = 32.9$ , years,  $SD = 4.42$ ) and their mean level of education, on a scale

of 1 (elementary school) to 7 (college degree or more), was 4.95 ( $SD = 1.77$ ); the category equivalent of 5 is high school degree. Most parents indicated that they were born in The Netherlands (94%). The sample contained 73 firstborn infants and 56 later-born infants.

The current study used data from the third (age 5), fourth (age 7), and sixth (age 12) waves of the Nijmegen Longitudinal Study, as these waves contained the variables of interest. Of the original sample of 129 children, 110 children participated in the Age 5 assessment ( $M_{\text{age}} = 5.3$  years,  $SD = .10$ ; 51% boys), 108 children participated in the Age 7 assessment ( $M_{\text{age}} = 7.4$  years,  $SD = .17$ ; 51% boys), and 94 children participated in the Age 12 assessment ( $M_{\text{age}} = 12.4$  years,  $SD = .28$ ; 48% boys). To determine whether there was selective drop-out, attrition analyses were performed with the sample with complete data at all time points (63%), and the sample with incomplete data (37%). Independent  $t$ -tests indicated no significant differences between the two samples on any of the included measures or in demographic variables (including education level and age of the primary caregiver, parental marital status and country of birth parents).

## 2.2 | Procedure and measures

### 2.2.1 | Age 5. Parental behavior

Parent-child interactions were videotaped at home during a structured 10–12-minute parent-child interaction discourse task, in which the parent asked the child to talk about various emotions and events from the past that had elicited these emotions. The parent (i. e., the primary caregiver) and child were consecutively presented with four pictures of a child displaying the emotions happy, anxious, sad and angry. The parent had been instructed to first ask their child to tell them what the child in the picture was feeling, and to explain this to their child if he or she failed to recognize the emotion depicted. Next, the parent was to ask if the child had ever felt like this in the past (no specification of the length of time children were asked to recall) and what had happened to make him or her feel that way. Parents were told that they were free to help the child remember examples and events. A new picture was presented after 2.5 min. The discourse task was rated for the quality of parental behavior using five 7-point scales (Erickson, Sroufe, & Egeland, 1985): (1) supportive presence or the provision of emotional support; (2) respect for the child's autonomy or non-intrusiveness; (3) effective structure and limit setting; (4) quality of instructions; and (5) hostility. The discourse task was independently rated for the quality of parental interactive behavior by four trained observers. The interrater reliability was computed for the complete recordings of 20% of the tapes. Cohen's Kappas exceeded 0.89 for all of the scales in the discourse task.

To obtain a robust measure for parental behavior, the five ratings were factor-analyzed using varimax rotation. Scree plots of eigenvalues indicated the emergence of one factor which explained 64% of the variance in parental behavior, with high positive loadings of supportive presence (0.91), respect for autonomy (0.86), structure and limit setting (0.67), and quality of instruction (0.82), and a negative loading of hostility ( $-0.72$ ). A composite score was computed by first reverse coding the hostility subscale and then calculating the mean of standardized scores of the five subscales ( $\alpha = .85$ ). A higher score indicated higher parenting quality.

### 2.2.2 | Age 7. Child temperament

Child temperament was evaluated by parents using the Children Behavior Questionnaire (CBQ; Rothbart, Ahadi, Hershey, & Fisher, 2001). The CBQ comprises 195 items, organized in 15 dimensions. Items are rated on a 7-point scale ranging from 1 = *extremely untrue* to 7 = *extremely true*. The 15 dimensions create factor scores for 'surgency', 'negative affectivity', and 'effortful control'. The child's score for the temperamental dimension of 'negative affectivity' was used in this study as a moderator and is composed of the subscales sadness, fear, anger/frustration, discomfort and the reversed subscale of soothability (Rothbart, Ahadi, & Hershey, 1994). Higher scores indicated greater negative affectivity ( $\alpha = 0.71$ ).

TABLE 1 Correlations, means, and standard deviations of all variables

Variables	1	2	3	4	M	SD
1. Observed parenting (age 5)	–				.03	.67
2. Mother reported temperament (age 7)	–.14	–			2.87	.54
3. Teacher reported Internalizing behavior (age 12)	–.01	.33**	–		5.67	5.32
4. Teacher reported externalizing behavior (age 12)	–.26**	.14	.22*	–	3.58	4.98

<sup>a</sup>Note. \* $p < .05$ , \*\* $p < .01$ .

### 2.2.3 | Age 12. Child internalizing and externalizing behavior

Teachers completed the Teacher Report Form (TRF; Achenbach, 1991; Verhulst, van der Ende, & Koot, 1997) to report on child behavior problems. The Anxious/Depressed (16 items), Withdrawn/Depressed (eight items), and Somatic Complaints (nine items) were summed to determine the internalizing behavior score ( $\alpha = 0.88$ ); the externalizing behavior score was based on the summed scores for the subscales Aggressive behavior (20 items) and Rule-breaking behavior (12 items) ( $\alpha = 0.94$ ).

## 3 | RESULTS

### 3.1 | Preliminary analyses

One outlier ( $>3$  SD from group mean) was detected in the parenting composite scale and was excluded from the analyses. Missing data ( $n = 19$  at Age 5,  $n = 21$  at Age 7,  $n = 35$  at Age 12), were at random, as indicated by the nonsignificant ( $\chi^2 = 11.10$ ,  $p = .76$ ) Little's Missing Completely At Random (MCAR) test (Little, 1988). We used Multiple Imputation techniques module of LISREL 8.7 with the expected maximization (EM) algorithm which is recommended as a modern missing data handling technique (Baraldi & Enders, 2010; Schafer & Graham, 2002). When analyses were run with only cases with complete data, results did not differ from those derived from the imputed data set. Imputed data were used in further analyses.

Table 1 shows correlations, means and standard deviations of all variables. Parenting quality was significantly related to teacher reported externalizing behavior, with higher parenting quality related to lower levels of externalizing behavior, but not to internalizing behavior. Furthermore, higher levels of negative affectivity were related to higher levels of internalizing behavior.

### 3.2 | Externalizing behavior

#### 3.2.1 | Hierarchical multiple regression analysis

We first ran a hierarchical multiple regression analysis, with predictor variables entered in five steps. To control for possible differences between girls and boys in problem behavior, we entered gender at Step 1. At Step 2, we entered the main effects: the effect of parenting behavior and child negative affectivity. At Step 3, the interaction of parent quality and negative affectivity was added. To estimate an additional model, with nonlinear terms included, we entered the parenting by parenting interaction at Step 4, and the parenting by parenting by negative affectivity interaction at Step 5. When these effects are not significant, the initial model without nonlinear effects is reliable (Roisman et al., 2012).

The results of regression analysis revealed that, in Step 1, gender did not significantly predict externalizing behavior. When parenting and negative affectivity were entered in Step 2, there was only a main effect of parenting ( $\beta = -.23$ ,  $p < .05$ ). In Step 3, the interaction of parenting and negative affectivity was significant ( $\beta = -.19$ ,  $p < .05$ ). The quadratic interactions (parenting  $\times$  parenting:  $\beta = .02$ ,  $p > .10$ ; parenting by parenting by negative affectivity:  $\beta = -.06$ ,  $p > .10$ ) were not significant and adding these interactions significantly worsened the model fit. Therefore,

**TABLE 2** Hierarchical regression analyses: parenting (age 5), temperament (age 7), internalizing and externalizing behavior (age 12)

Step	Predictor	Externalizing behavior			Internalizing behavior		
		F	$\Delta R^2$	Beta	F	$\Delta R^2$	Beta
Step 1	Gender	.64	.01	-.09	.07	.00	-.06
Step 2	Parenting	3.82**	.07	-.23**	5.38**	.11	.03
	Temperament			.11			.34**
Step 3	Parenting X temperament	4.20**	.04	-.19*	4.67**	.02	-.13

<sup>a</sup>Note. \* $p < .05$ , \*\* $p < .01$ .

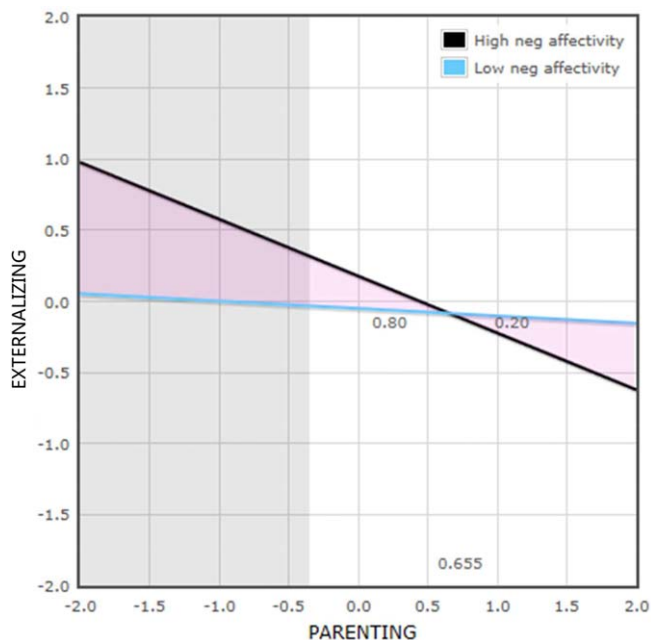
the model without nonlinear effects was considered to be the final model. Results of this final model are displayed in Table 2. The proportion of variance significantly explained by the four predictors was 0.12.

### 3.2.2 | Simple slope analyses

Next, to interpret the significant parenting by negative affectivity interaction, we plotted the regression slopes of parenting on externalizing behavior separately for children high and low on negative affectivity. Figure 2, based on  $\pm 1$  SD of the moderator, indicates that whereas the relation between parenting and externalizing behavior was negative and significant in the case of children high on negative affectivity ( $\beta = -.40$ ,  $p < .05$ ), it was not significant and close to zero in the case of children who scored low on negative affectivity ( $\beta = -.05$ ,  $p > .10$ ).

### 3.2.3 | Probing interactions

Figure 2 also reveals a cross-over interaction. According to Roisman (2012), the recommended practice (Aiken & West, 1991) of probing interactions within a range of  $\pm 2$  SD from the mean for the independent variable should be used to interpret data. This indicated that the cross-over interaction in Figure 2 is consistent with differential susceptibility



**FIGURE 2** Interaction effect of parenting X negative affectivity on externalizing behavior

theory, in that children with high levels of negative affectivity had the highest externalizing behaviors when exposed to low quality parenting and the lowest externalizing problems when parenting quality was high.

### 3.2.4 | Regions of significance analyses

It is recommended to conduct 'regions of significance' analysis (Kochanska et al., 2011; Preacher et al., 2006) to distinguish empirically differential susceptibility from diathesis stress. We examined both regions of significance on the moderator (RoS on Z; Preacher et al., 2006) and regions of significance on the independent variable (RoS on X; Dearing & Hamilton, 2006; Roisman et al., 2012), using a web-based program developed by Chris Fraley which is freely available at <http://www.yourpersonality.net/interaction/>.

RoS on moderator (Z) provides information about the entire range of values of the moderator (negative affectivity) for which parenting and externalizing behavior are significantly associated. The analysis yielded a lower ( $-24.44$ ) and higher ( $-0.03$ ) bound of values for negative affectivity at which the regression of externalizing behavior on parenting was statistically significant ( $\alpha = 0.05$ ). The upper bound value, but not the lower bound value, is between  $\pm 2$  SD from the mean and is considered informative: Parenting was significantly associated with externalizing behavior for children with scores at or above  $-0.03$  on negative affectivity.

Next, we examined RoS on the independent variable (X) which is informative about the range of parenting for which negative affectivity and externalizing behavior are significantly related. The association between negative affectivity and externalizing behavior was significant for all values of parenting below  $-0.35$  and above  $14.48$ . A differential susceptibility pattern would yield both upper and lower bounds of the region of significance within the observed parenting range (within  $\pm 2$  SD from the mean of parenting). Analysis yielded only a lower bound of significance within the observed range of parenting (value of  $-0.35$ ); more specifically, the slope between negative affectivity and externalizing problems was significant only when parenting was below  $-0.35$  (see shaded area in Figure 2). There were no significant differences above this value. The significant interaction between parenting and temperament in predicting externalizing problems was therefore more consistent with diathesis-stress than with differential susceptibility theory.

### 3.2.5 | Crossover point, proportion of the interaction, and PA analyses

Additional analyses for evaluating differential susceptibility (Roisman et al., 2012) indicated that the crossover point of the simple slopes on parenting was at  $.67$ , within the range of  $\pm 2$  SD from the mean of parenting ( $M = .00$ ,  $SD = 1.00$ ). The proportion of the interaction (PoI) below the crossover point was  $0.80$ , and the proportion above the crossover point was  $0.20$ . A prototypic differential susceptibility case would have a value of  $50\%$  for the PoI on the right side of the crossover point for the interaction. For a prototypic diathesis stress case this value would be  $0\%$ . The proportion of interaction ( $20\%$ ) that is presented on the right side (the 'for better' side) of the crossover point for the interaction in Figure 2 therefore excludes differential susceptibility, and seems to be more in line with diathesis stress. Finally, the PA index indicates the proportion of cases that are differentially affected by the crossover interaction, that is, the proportion of cases from whom the association between negative affectivity and externalizing behavior is 'reversed or qualified' (Roisman et al., 2012). The PA with respect to externalizing behavior was  $0.26$ . Evidence for prototypical differential susceptibility would yield a value that includes a non-trivial proportion of people (e. g.,  $50\%$ ). For diathesis stress, the value will be closer to zero. Roisman and colleagues (2012) suggest a cut-off of  $0.16$ : If only  $16\%$  of the cases fall above the point at which the regression lines intersect, data might be consistent with differential susceptibility theory. The percentage of  $26\%$  is above the cut-off of  $0.16$ , indicating support for differential susceptibility.

## 3.3 | Internalizing behavior

### 3.3.1 | Hierarchical multiple regression analysis

The same analyses as for externalizing behavior were completed for internalizing behavior (Table 2). Again, we checked for nonlinear effects, but these were not significant and significantly worsened model fit. In the final equation, with the four predictors entered, there was only a significant main effect of negative affectivity on internalizing behavior ( $\beta = 0.34$ ,  $p < .01$ ). Children with higher levels of negative affectivity reported by mothers at age 7, showed higher



levels of internalizing behavior reported by teachers at age 12. The proportion of variance significantly explained in the final model was 0.13. There was no significant interaction effect between parenting and temperament. Consequently, we did not conduct the additional analyses to evaluate differential susceptibility.

## 4 | DISCUSSION

The aim of the current study was to investigate the longitudinal associations among parenting, children's negative affectivity and behavior problems, and to distinguish between diathesis-stress and differential susceptibility theory by including more stringent tests for moderation effects. Children's negative affectivity moderated the effects of parenting on children's later externalizing behavior, as reported by teachers. Visual inspection of the interaction effect ('eye-ball' test of graphed interactions; Belsky & Pluess, 2013) suggested that the results were in line with differential susceptibility theory; children with high levels of negative affectivity showed more behavior problems when parenting quality was low and fewer behavior problems when parenting quality was high. However, more stringent tests to evaluate differential susceptibility failed to show convincing evidence for this 'for better and for worse' hypothesis. Apparently, compared to children with lower levels of negative affectivity, children with higher levels of negative affectivity seemed to be vulnerable to adverse parenting—confirming the diathesis-stress model rather than differentially susceptible to parenting. Their temperamental characteristics placed these children at higher risk for externalizing problems in low parenting quality environments. Regarding internalizing behavior, no support was found for either differential susceptibility or diathesis-stress models. This suggests that negative affectivity may render children vulnerable for the development of internalizing behavior, regardless of parenting quality.

### 4.1 | Differential susceptibility under certain conditions

Differential susceptibility theory has important implications for understanding why and how much children's development responds to environmental exposures. Up to now, however, it appears that support for differential susceptibility theory may only be found under certain conditions. Based on our findings, a condition under which differential susceptibility might be found concerns timing. Is it the case that because of the plasticity of neurobiological systems children are more susceptible, both to the good and the bad, during early stages of life (Ganzel & Morris, 2011)? In contrast to most other studies supporting the differential susceptibility model, the current study, measured temperament in middle childhood and not in infancy or toddlerhood. From our results, we concluded that heightened negative affectivity assessed at age 7 makes children vulnerable to low parenting quality. But perhaps these children were susceptible, and thus also profited more from positive parenting, at younger ages. The results from the current study suggest that temperament is a suitable marker for differential susceptibility when assessed early in life and a suitable marker for vulnerability when assessed later in life, but this hypothesis clearly needs additional testing.

Variability in susceptibility at later ages may still be captured using other measures. Because temperament is presumed to have a genetic or neurobiological basis (Goldsmith et al., 1987), specific genes may reflect genetic sensitivity better than a behavioral temperament measure. Two meta-analyses have focused on how genes (i. e., the 5-HTTLPR gene and dopamine-related genes) moderated the effects of environment (Bakermans-Kranenburg & van IJzendoorn, 2011; van IJzendoorn, Belsky, & Bakermans-Kranenburg, 2012). It was found that children with less efficient dopamine-related genes and with the short allele of the 5-HTTLPR gene did worse in negative circumstances compared to children without these 'at-risk' genes, but they also profited more from positive environments. These genetic moderation effects on behavior were also found at an older age (>10 years old; Bakermans-Kranenburg & van IJzendoorn, 2011). In addition to genetic measures, measures of individual differences in reactivity of neurobiological stress response systems may be better indices of susceptibility later in development (Blandin, 2013; Boyce & Ellis, 2005). For example, more recently the Sensory Processing Sensitivity has been suggested as a marker for differential susceptibility (Aron, Aron, & Jagiellowicz, 2012), and it entails a low sensory threshold and high sensitivity to subtle stimuli which makes individuals more strongly affected by their environment (Aron et al., 2012).

Second, Roisman and colleagues (2012) found evidence for the differential susceptibility theory and the diathesis stress model depending on who rated child outcomes: the mother or the teacher. Children with more negative affectivity were *differentially susceptible* to parenting for teacher reported social competence and academic skills. However, for the mother reported outcomes and for the objective tests of academic skills, they found more evidence for *diathesis-stress* effects. According to evolutionary theories, early experiences prepare children for the environment in which they will have to survive and reproduce at a later age, with some children being more affected by their environment than other children (Frankenhuis & de Weerth, 2013). As a result, children learn to behave in a manner that is adaptive to this specific environment. However, at a certain age, children have to function in more than one environment at the same time, such as the home and school environments, and adaptive behaviors in one environment might be very well (seen as) non-adaptive in another environment. The hypothesis that differential susceptibility versus diathesis stress results might depend on the environment in which child outcomes are measured and by whom, clearly needs further testing.

Finally, in a review on parenting in the context of child temperament (Kiff, Lengua, & Zalewski, 2011) it has been suggested that inconsistencies in interaction findings across studies (i. e., findings in line with specific models of differential susceptibility or a diathesis-stress model) might be a result of interacting variables that are moderating the associations (e. g., multiple temperament characteristics, or multiple parenting behaviors) or measurement issues (i. e., different operationalizations for the same variable, different measurement methods) (Kiff, Lengua, & Zalewski, 2011). These suggestions should be topic of future research.

## 4.2 | Parenting, temperament, and externalizing behavior

As in line with many other studies (e. g., Grusec, 2011; Rothbaum & Weisz, 1994), parenting quality predicted externalizing behavior. However, to more fully understand the development of externalizing behavior, our findings suggest that we should consider the role of child temperament along with the effects of parenting. Processes that are underlying these relations are not entirely clear yet. A possible mediating factor for the parenting-externalizing behavior association, especially for the children with higher negative affectivity, could be children's regulation strategies (Sroufe, 1996). During the early years, children depend on their parents for external regulation of their emotion, and, over time they learn from their parents how to regulate themselves (Schore, 2001). There is indeed evidence suggesting that parenting and negative affectivity interact to predict emotion regulation (Gilliom, Shaw, Beck, Schonberg, & Lukon, 2002), and in turn, deficits in ability to regulate emotions have been linked to problems in emotional, social and cognitive domains, including externalizing problems (Eisenberg et al., 2001). Children with high levels of negative affectivity find it especially difficult to regulate arousal and their emotions, and as a result they are in higher need of high quality parenting as they need help to externally regulate their affect and to develop their own regulatory capacities (Albers, Beijers, Riksen-Walraven, Sweep, & de Weert, 2016; Jaffe, Gullone, & Hughes, 2010). Although some studies have examined components of this suggested mediation model (e. g., temperament  $\times$  emotion regulation; see Eisenberg, Spinrad, & Eggum, 2010 for a review) and we are now beginning to see studies that examine potential mechanisms (see Bates & Pettit, 2015 for a review; Schermerhorn et al., 2013), more research is needed to identify the possible mechanisms, including emotion regulation and social learning, that underlie associations between parenting, temperament, and child externalizing behavior.

## 4.3 | Parenting, temperament, and internalizing behavior

For internalizing behavior, we found negative affectivity to be a significant predictor whereas there were no significant effects of parenting. These results are consistent with the *vulnerability model* (Nigg, 2006) in which children who exhibit temperamental vulnerabilities are predisposed to develop certain kinds of psychopathology, whether a environmental risk factor is present (Luthar, Cichetti, & Becker, 2000). Moreover, findings align with the *tripartite framework* of internalizing disorders in which it is stated that negative affectivity is present in both anxiety and depression (De Bolle & de Fruyt, 2010, De Pauw & Mervielde, 2010).

In a longitudinal study on predicting internalizing disorders in children (Kiff, Lengua, & Bush, 2011), it was also found that some children with temperamental vulnerabilities showed more symptoms regardless of the parenting they received. Can we conclude that internalizing problems are predominantly a result of factors within the child? In the current study, we observed parent-child interactions during a structured task and coded the quality of these interactions. *These specific* aspects of parenting—measured at only one time point—were not longitudinally related to teacher reported internalizing problems of the child. Still, it is possible that other aspects of parenting behaviors, such as modeling and overprotection are more important predictors for internalizing problems (Bogels & Brechma-Toussaint, 2006). Moreover, it could be the case that parenting and temperament are more intertwined—parenting and temperament may simultaneously influence each other and moderate each other's impact on internalizing problems (Lengua & Kovacs, 2005)—and this could be examined in studies including multiple time points of observed parenting, temperament, and internalizing behavior.

Conversely, recent studies on effects of child versus parent interventions for children with internalizing problems show that intervening with parents (i. e., changing parenting behaviors) is not additionally effective in reducing child internalizing behavior compared to cognitive interventions for the child (Bodden et al., 2008; In-Albon & Schneider, 2007). Other studies have shown that intergenerational transmission of genetic risk factors is a strong predictor of child internalizing problems whereas family status variables and parental relationship contribute less (Pettit, Olino, Roberts, Seeley, & Lewinsohn, 2008).

Thus, although temperament—as an innate or biologically shaped basic disposition—seems to be important in predicting internalizing behavior, other parenting measures—not included in the current study—might interact in combination with high levels of child negative affectivity when predicting internalizing problems in children.

#### 4.4 | Strengths and limitations

This study had several strengths including a longitudinal design, multi-method, and multi-informant assessment and more stringent tests of differential susceptibility versus diathesis stress theory, with associations examined in a community sample. However, some limitations of the study should also be mentioned. First, to be able to distinguish differential susceptibility from diathesis stress, a focus on both negative and positive outcomes (e. g., prosocial behavior, social competence) is preferred. Second, although in line with results of other studies examining parent by temperament interactions (Bates & Pettit, 2015), when interpreting findings of the current study it is important to realize that interaction effects do not account for large portions of variance in the outcome variables. A third limitation is the small sample size, particularly with regard to evaluating moderating effects. Although the sample size was adequate for detecting two-way interactions (Aiken & West, 1991), perhaps power was too low to detect higher order effects, such as the curvilinear parenting effects. Future studies that examine interactions among parenting and temperament, and especially testing curvilinear effects, are needed to determine whether the pattern of findings is replicable. Finally, parenting, temperament and internalizing and externalizing behavior were not measured at multiple time-points, which prevents us from drawing conclusions about direction of effects. It is possible that parenting and temperament simultaneously interact with each other and shape each other, as suggested by reciprocal predictive effects between parenting and temperament (e. g., Lengua & Kovacs, 2005).

Notwithstanding these limitations, the current study adds to the growing body of research on person by environment interactions. Although visual inspection of the cross-over point of our data suggested that children with high levels of negative affectivity may be highly susceptible to parenting quality in the 'for better and for worse' matter, further testing indicated no convincing evidence for differential susceptibility. Apparently, children with a predisposing 'diathesis', namely high negative affectivity, are vulnerable to environmental stressors, in line with the diathesis stress model. Thus, children who show high levels of negative affectivity in childhood seem to be disproportionately susceptible to the negative effects of low quality parenting, but reach comparable levels of externalizing behavior when exposed to high quality parenting.

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