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Temperament Moderates Associations between Exposure to Stress and Children's Externalizing Problems

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Abstract

The interaction between a temperament profile (four groups determined by high vs. low resistance to control [unmanageability] and unadaptability [novelty distress]) and family stress in predicting externalizing problems at school in children followed from kindergarten through 8th grade (ages 5 – 13) was investigated. The sample consisted of 556 families (290 boys). At Time 1 just prior to kindergarten, mothers retrospectively reported on their child's temperament during infancy. Each year, mothers reported stress and teachers reported children's externalizing problems. Temperament profile was tested as a moderator of the stress-externalizing association for various time periods. Results indicated that the combination of high resistance to control and high unadaptability strengthens the stress-externalizing association. Findings are discussed in terms of possible underlying mechanisms.

Keywords: Temperament, Stress, Externalizing Problems, Self-regulation, Fearfulness

Temperament Moderates Associations between Exposure to Stress and Children's Externalizing Problems

Stressful life events have been associated with children's psychosocial adjustment problems (Compas, 1987). However, it appears that children are not all equally affected by stress (Garmezy, Masten, & Tellegen, 1984; Jackson & Frick, 1998). Individual differences in temperament may increase some children's risk of difficulties when faced with stress (Compas, Connor-Smith, & Jaser, 2004). Moreover, generalizing from the few studies of temperament X temperament interaction effects (Eisenberg et al., 2000; Rothbart & Bates, 2006), certain combinations of temperament dimensions, characterized by a temperament profile, may place stressed children at especially great risk. One likely risk-enhancing combination is high levels of both self-regulatory difficulties and fearfulness. The present study tests whether such characteristics in children interact to strengthen the association between exposure to stress and children's externalizing problems.

Stress and Well Being

Children's adjustment problems have been predicted by a host of stressors, including parental marital problems (Cummings & Davies, 2010), family violence (Dodge, Pettit, & Bates, 1997), and economic stress (Conger et al., 2002). The role of individual differences in altering these associations has received theoretical (Compas et al., 2004; Wachs, 2006) and empirical support (Lansford et al., 2006; Wertlieb, Weigel, Springer, & Feldstein, 1987).

Temperament

Temperament has been defined as biologically based individual differences in reactivity and self-regulation (Rothbart & Bates, 2006). Specific dimensions of temperament have been differentially associated with children's subsequent adjustment problems. Early tendencies

toward impulsivity have been related to later externalizing problems, and early tendencies toward fearfulness have been related to later internalizing problems (Bates, Bayles, Bennett, Ridge, & Brown, 1991; Bates, Maslin, & Frankel, 1985; Keiley, Lofthouse, Bates, Dodge, & Pettit, 2003). Thus, evidence suggests that temperament is linked with psychosocial adjustment problems. However, the link is only moderately strong, which suggests that other factors, such as environmental stressors, might contribute to the development of adjustment problems.

Interactions between Temperament and Environment

The stressors of interparental conflict and peer and neighborhood risk factors have been found to interact with temperament. Specifically, low effortful control has been found to strengthen the positive association between destructive interparental conflict and poor social functioning (David & Murphy, 2007). Moreover, neighborhood poverty has been found to strengthen the positive association between impulsivity and antisocial behavior (Lynam et al., 2000). Similarly, the positive association between affiliation with deviant peers and externalizing has been found to be stronger for children with poor self-regulation (Gardner, Dishion, & Connell, 2008; Goodnight, Bates, Newman, Dodge, & Pettit, 2006). Finally, the serotonin transporter gene (perhaps a proxy for temperament) has been found to interact with stress to predict internalizing outcomes (Caspi, Hariri, Holmes, Uher, & Moffitt, 2010).

Although few studies have examined interactions between temperament and stress, recent years have seen dramatic increases in studies examining interactions between temperament and other environmental factors, especially parenting (Bates & Pettit, 2007; Rothbart & Bates, 2006). One replicated finding is that high levels of temperamental self-regulatory deficits have been more strongly associated with externalizing problems for children whose parents were low in control and firm discipline or high in inconsistency (Bates, Pettit, Dodge, & Ridge, 1998;

Lengua, Wolchik, Sandler, & West, 2000). A possibility suggested by these findings is that parents' use of firm control eventually reshapes these children's self-regulatory abilities.

Studies have also examined temperament-related fearfulness in interaction with parenting. Fearfulness was more strongly related to psychosocial adjustment problems in the context of parental rejection and more weakly related in the context of parental warmth in a study by Sentse, Veenstra, Lindenberg, Verhulst, and Ormel (2009). Relatedly, Kochanska (1991, 1995, 1997) found that mothers' power assertion and negative discipline predicted lower levels of internalized self-control (e.g., less compliance) among highly fearful children. This is particularly interesting because deficient self-control is often thought of as an externalizing problem, and by itself, fearful temperament would be most pertinent to internalizing problems. Similarly, Colder, Lochman, and Wells (1997) found that fearful children exposed to harsh discipline had more aggressive behavior in school, compared with children whose parents used gentle discipline and compared with fearless children. To account for such findings, Kochanska (1997) suggested that the emotion-arousing nature of harsh punishment may especially impair fearful children's higher-order cognitive processing because of these children's tendencies to have elevated arousal. Hoffman (2000) has also argued that over-arousal would impair children's abilities to internalize the moral meaning of parental discipline.

In summary, there is some evidence of interactions between temperament dimensions and such stressors as interparental conflict. In addition, there have been replicated findings of interactions between temperamental self-regulatory deficits and parental control influencing externalizing problems. There have also been replicated findings of interactions between fearful temperament and harsh parenting predicting adjustment problems, including externalizing

problems. Taken together, these studies suggest that interactions between temperament and aspects of the environment have important implications for child externalizing problems.

Interactions between Dimensions of Temperament

Several studies have examined how dimensions of temperament interact with each other to predict adjustment problems. Lonigan, Vasey, Phillips, and Hazen (2004) found that both negative emotionality and self-regulation problems were necessary for the development of anxiety problems, suggesting that children with negative emotionality but not self-regulation problems were able to regulate their negative arousal, preventing anxiety problems from developing. In addition, some studies have found self-regulatory deficits and negative emotionality interact to predict *externalizing* problems. For example, Eisenberg et al. (2000) found that negative emotionality strengthened associations between poor attentional control (a self-regulation problem) and externalizing behavior. Muris, Meesters, and Blijlevens (2007) found that effortful control weakened the positive association between negative emotionality and both internalizing and externalizing.

To summarize, recent work provides evidence that temperament-related self-regulatory difficulties and negative emotionality interact with one another. Based on studies described earlier in this paper, there is also evidence that temperament interacts with potentially stressful aspects of the environment in predicting externalizing problems. However, we are not aware of studies that have established both kinds of interaction simultaneously. We next discuss a conceptual model that we believe provides a useful framework for such a complex process.

Conceptual Basis for Predicting a Self-regulatory-by-Fearfulness-by-Stress Interaction

Drawing on Gray's well known brain model (e.g., Gray, 1991), Newman and Wallace (1993; Wallace & Newman, 1997) argued that psychopathology results from the activity of

neural systems controlling approach behavior (behavioral activation system; BAS), inhibition behavior (behavioral inhibition system; BIS), and the nonspecific arousal system (NAS). The BAS is sensitive to reward cues and initiates motor responses in the service of approach. The BIS directs attention to possible danger stimuli or punishment cues, and interrupts any ongoing or planned behavior. Both BAS and BIS activation increase NAS activation. NAS activation produces rapid, automatic responses, which are relatively immune to regulatory efforts, potentially resulting in behavior that is overly intense (Wallace & Newman, 1997).

The implication from Newman and Wallace's work that intrigued us was the possibility that children who have temperamental inclinations toward arousal can experience more externalizing problems, and that this may be particularly heightened in environments that are especially arousing (Bates, Sandy, Dodge, & Pettit, 2000). Kochanska's (1995, 1997) findings are consistent with the prediction we take from Newman and Wallace (1993; Wallace & Newman, 1997). In addition to the interference of emotion with learning (Hoffman, 2000; Kochanska, 1997), the nonspecific arousal experienced by fearful children might increase the strength of approach responses and make flexible switching to the non-dominant, inhibitory mode of behavior less likely. Do children who have dispositions to both poor regulation of approach behaviors and easy arousability show more externalizing problems in stressful environments than would be predicted by the main effects of either or both temperament risk factor? The theoretical and empirical work of Kochanska (1995, 1997), Gray (1991), and Newman and Wallace (1993; Wallace & Newman, 1997) suggests that this might be so.

Would other temperament combinations also lead to externalizing problems? The most likely alternative combination might involve high levels of anger proneness and self-regulatory deficits. Although this combination may lead to externalizing in the context of stress, we think it

would be more likely to lead to externalizing in response to anger-eliciting events, such as during conflict with a parent. In contrast, we think highly fearful children are particularly likely to engage in externalizing behavior in the context of stress, because of the especially arousing effects of stress on these children. There is a particularly strong theoretical basis for understanding the connections of self-regulatory deficits and fearfulness with externalizing in contexts of stress. Although other temperament combinations might also increase children's risk for externalizing problems in general or in response to anger-eliciting events, we cannot identify any with as clear a theoretical connection to externalizing in the context of stress.

The Current Study

We focus on the temperament dimensions of resistance to control and unadaptability in the current study. Resistant temperament refers to a developmentally early form of unmanageability involving not following simple directives (e.g., playing with objects after being told to leave them alone). This dimension of temperament is thought to reflect deficient self-regulation resulting in part from strong approach motivation (BAS) (Bates et al., 1998). Unadaptable temperament refers to fearfulness or distress in novel situations (e.g., being around new people) and is conceptually related to the BIS. Unadaptability is conceptualized as a prototypical disposition to anxiety (e.g., see Kagan, 1998).

Prior interpretations in the literature led us to hypothesize that the proto-anxiety tendencies represented by high unadaptability would serve to amplify the effects of high levels of family stress, because of increased nonspecific arousal, and make it more likely that resistant temperament would be expressed in externalizing behavior (Bates et al., 2000). To examine this possibility, we tested for a three-way (resistance-by-unadaptability-by-stress) interaction effect on externalizing problems using structural equation modeling.

In order to do this, we formed temperament groups reflecting the four possible combinations of high and low levels of resistance and unadaptability. 1) One group of children was relatively easily manageable in approach situations and was also relatively accepting of novelty. 2) Second were those who were easily manageable but also distressed by novelty. 3) There were also children who were hard to manage in approach situations, but were accepting of novelty. 4) Finally, there was the group we expected to be most at risk, children unmanageable in approach situations and at the same time distressed in novel situations. We tested this 3-way interaction for several different age periods. The principal reason for doing so was that we wanted to examine the consistency and reliability of the findings across different ages—that is, could findings in one developmental era be replicated in another developmental era?

Method

Participants and Procedure

The families in this study were participants in the Child Development Project (Dodge, Bates, & Pettit, 1990). Participants were recruited during kindergarten preregistration when the children were entering kindergarten in 1987 or 1988 in Knoxville, TN, Nashville, TN, and Bloomington, IN. Because about 15% of children do not pre-register, that proportion of the sample was recruited at the time of kindergarten enrollment. Approximately 75% of families who were asked agreed to participate. Comparisons were made between participating children and non-participating children using kindergarten, 1st grade, and 2nd grade peer-nominated sociometric scores for popularity and rejection that were available for the entire school population, and no significant differences were found (Dodge, Pettit, & Bates, 1994). Data from the 556 children (of the total *N* of 585) whose mothers completed the temperament measure were included in the current study. Fifty-two percent (*n* = 290) of the children were male. Eighty-one

percent of the children were European American, 17% were African American, and 2% were from other ethnic groups. Sixty-six percent of the children's biological parents were married or cohabiting; 8% of the children lived with one of their biological parents and the parent's spouse or partner; the remaining 26% of the children lived in single-parent households.

The mean on the Hollingshead four-factor index of social status was 39.8 (*SD* = 14.0). The breakdown of SES by Hollingshead category was 8.4% in the lowest SES category, 16.6% in the next lowest category, 25.2% in the middle category, 32.9% in the second highest SES category, and 16.8% in the highest SES category. Thus, the sample was primarily middle-class, but included a wide range of socioeconomic levels. Local institutional review boards approved all questionnaires and procedures, and parents and children provided consent or assent.

Measures

Temperament. When the children were 5 years old, mothers completed the Retrospective Infant Characteristics Questionnaire (RICQ), which is based on the Infant Characteristics Questionnaire (Bates & Bayles, 1984; Bates, Freeland, & Lounsbury, 1979), providing a measure of the children's temperament traits as infants. Because more mothers than fathers provided temperament reports, in order to include as many families as possible, only mothers' reports were used. Parent-report measures generally converge, to a modest-to-moderate degree, with other methods of measuring temperament, such as observational methods (Bates & Pettit, 2007). The resistance to control subscale of the RICQ assesses early unmanageability, especially continuing to engage in prohibited activities when told to stop. Items assess infants' persistence in playing with forbidden objects, continuing to go where told not to, and distress when removed from a desired object or situation. Items were completed using a 7-point scale ranging from *rarely/never* (1) to *almost always/always* (7). The unadaptability

subscale of the RICQ assesses early fearfulness in novel situations. Items assess responses to new foods, people, places, and experiences. Items were completed using a 7-point scale ranging from *always favorable/very well liked* (1) to *always negative or fearful/almost always disliked* (7).

Item scores were averaged to create a resistance score and an unadaptability score for each child. Cronbach's alphas were .83 for resistance and .72 for unadaptability. Regarding validity, mothers' concurrent reports of their child's temperament in infancy were correlated with their subsequent retrospective reports when their child was 10 years old (Bates et al., 1998). Maternal reports of early resistance have been found to predict subsequent teacher-reported externalizing, and maternal reports of early unadaptability have been found to predict subsequent teacher-reported internalizing (Bates et al., 1991; Bates et al., 1985; Keiley et al., 2003).

Stress. Mothers reported the occurrence of 18 stressful life events during the previous year (Changes and Adjustments Scale; Dodge et al., 1994). The events were family relocating, home repairs or remodeling, target child (TC) frequent or severe illness, TC accident or injury, other medical problems for TC, other close individuals' medical stress, financial problems, death of a close family member, death of another important person, divorce or separation of TC's parents, TC separation from parent, problems or conflict in extended family, birth of a sibling, TC school problems, parent work problems, parent loss of job, parent remarriage or reconciliation, and legal problems. To increase data collection feasibility, only mothers were asked to report on stress. Stress reports from kindergarten through 8th grade were used in the current study.

The checklist was completed as an interview during the Kindergarten, 6th, and 8th years, and as a questionnaire via postal mail the other years. When completed as an interview, each

event was rated on a 3-point scale, consisting of *No, did not occur* (0), *Mentioned, minor stressor* (1), and *Emphasized, major stressor* (2). When completed as a questionnaire, each event was rated either *No, did not occur* (0) or *Yes, did occur* (1). To put the interview and questionnaire data on the same scale, we rescaled interview scores of 2 with a value of 1. The total score was computed by summing the responses for each year. Cronbach's alpha = .64, and mother and father reports on stress have been found to intercorrelate highly, r = .71 (Dodge et al., 1994).

Externalizing problems. Teachers completed the Teacher Report Form (TRF; Achenbach, 1991), providing a measure of children's externalizing problems. TRFs were completed 6 months ± 2 months after mothers reported on stress (i.e., midway through the school year). Items assess aggression and rule-breaking (e.g., "Argues a lot"). Teachers rated each item using a 3-point scale from *not true of the pupil* (0) to *very true or often true of the pupil* (2). The ratings were summed to create externalizing scores, following procedures described by Achenbach (1991). Widely used and empirically derived, the TRF has acceptable reliability and validity. In the current sample, Cronbach's alphas ranged from .94 in Year 1 to .96 in Year 9.

Data Analyses

We conducted structural equation modeling (SEM) using Analysis of Moment Structures (Amos; Arbuckle & Wothke, 1999). Acceptable fit is indicated by non-significant χ^2 values, χ^2/df values below 3.0 (Bollen, 1989), CFI and NFI values above .90 (Hu & Bentler, 1999), and RMSEA values less than or equal to .08 (Browne & Cudeck, 1993).

We created latent stress variables using stress scores at three consecutive time points (e.g., kindergarten, 1st grade, and 2nd grade) and created latent externalizing variables using externalizing scores at three consecutive time points (e.g., 3rd, 4th, and 5th grades). This approach has been used successfully in many previous studies, and we adopted it for several reasons.

First, consecutive stress scores were positively correlated at the $p < .001$ level, and all externalizing scores were also positively correlated at the $p < .001$ level (see Table 1), justifying their use as manifest indicators of the latent variables. Second, this approach allowed us to form latent constructs that reflected chronic stress, which is especially closely related to adjustment problems (Compas, 1987), and third, it allowed us to examine chronically elevated externalizing scores. Fourth, given that some families did not participate in some years, this approach allowed us to include more participants in each model. Fifth, preliminary analyses examined each year's externalizing assessments separately, and the pattern of results was the same (Bates et al., 2000).

Our main objective in this initial study was to test our theory-based conceptualization that the combination of temperamental resistance and unadaptability would strengthen the association between stress and subsequent externalizing. Accordingly, autoregressive controls were not included in our primary analyses. Including autoregressive controls would test whether the stress X temperament interaction between predicts *change* in externalizing. The question of change is a very different and more advanced question than the more foundational question addressed by the current study. We did not have a theoretical reason to expect that the stress X temperament interaction would predict change in externalizing, whereas we did have a theoretical basis for expecting that it would predict subsequent *levels* of externalizing. However, to begin to examine the possibility of change, we did conduct a growth curve analysis as a secondary analysis. In addition, we examined associations between chronic stress and subsequent chronically elevated externalizing problems across different developmental windows, as we describe next. This allowed us to test the replicability of the findings across different developmental time-points.

Within a given year, stress was assessed 6 months (+/- 2 months) before externalizing; thus, in each model, the stress assessments preceded the externalizing assessments by at least 4

months. We tested the main effects of stress on externalizing problems in six models designed to consider several developmental windows (see Figure 1). For example, as illustrated in Figure 1, Model 1 has a window of stress from mother reports in pre-K to pre-2nd grade predicting a window of externalizing behavior from teacher reports in mid-2nd grade to mid-4th grade. The 3-year window approach resulted in superior latent constructs, and thus superior SEMs, compared with 1- or 2-year windows (Marsh, Hau, Balla, & Grayson, 1998). The developmental windows for each model are presented in Figure 1. Our developmental windows approach examines one snapshot at a time, repeated over a number of snapshots. This approach, combined with allowing some overlap between time points, provides a rich picture of the stress-externalizing association.

We tested temperament as a moderator of these associations using multi-group tests. We dichotomized resistance and unadaptability using a median split; children with scores at or below the median were considered low on that temperament dimension, and children with scores above the median were considered high on that dimension. We created four groups: a) low resistance-low unadaptability (n = 173, 31%), b) low resistance-high unadaptability (n = 105, 19%), c) high resistance-low unadaptability (n = 139, 25%), and d) high resistance-high unadaptability (n = 139, 25%). Although dichotomizing reduces power to detect significant effects (Cohen, 1978), it can enhance interpretability and produce clearer results, and this approach is commonly used in the temperament literature (e.g., Kochanska, 1997; Lengua, Bush, Long, Kovacs, & Trancik, 2008). There are other ways of dichotomizing variables, such as splitting at the scale's midpoint. However, we wanted the groups to reflect relatively high or low scores (e.g., higher or lower than half of the other scores in the sample). Another alternative is to include only participants within a smaller range of the distribution (e.g., the upper or lower 30%), reflecting more extreme scores. However, this would have reduced the sample size considerably.

We allowed the regression of externalizing problems on stress to vary for the four temperament groups in order to obtain the standardized regression coefficients for each group. Finding a larger coefficient for the high resistance-high unadaptability group than for the other groups would suggest that stress predicts externalizing problems more strongly for children who are high in both resistance and unadaptability (the "risk profile group") than for other children. To examine possible differences between the low resistance-low unadaptability, low resistance-high unadaptability, and high resistance-low unadaptability groups, we used χ^2 difference tests ($\Delta\chi^2$) to compare the fit of a model in which this path was constrained to be equal for these three groups (and free to vary for the risk profile group) with the fit of a model in which this path was allowed to vary for all groups. A non-significant difference in fit would indicate that these three groups do not differ significantly, providing justification for combining them.

The next step was to determine whether the standardized stress-externalizing regression coefficient was significantly larger for the risk profile group than for the other groups. To do this, we used $\Delta\chi^2$ tests to compare model fit with this path constrained to be equal for all four groups vs. free for the risk profile group, but constrained to equality for the other three groups. If significant, this test would indicate the high resistance-high unadaptability group had a stronger stress-externalizing association than the other groups.

Results

Preliminary Analyses

Compared with families who completed all nine waves, families who did not complete all nine waves had higher levels of stress in 2nd, 3rd, 5th, 6th, and 7th grades, and had higher externalizing scores in 5th grade. Because of the potential for missingness to bias our results, our

primary analyses used FIML estimation, which has performed well in tests of missing data approaches (Croy & Novins, 2005; Schafer & Graham, 2002).

Means, standard deviations, and correlations among temperament, stress, and externalizing are reported in Table 1. We also examined the bivariate correlations between stress and externalizing separately for each temperament group. The pattern of results was very similar to that of the primary SEM analyses presented in Table 3; the correlations are available from the authors upon request. Tests of the main effects of stress on externalizing are reported in Table 2. All models fit the data, and there was a significant main effect in every model.

Primary Analyses

For all primary analyses, factor loadings were significant and were similar to those reported in Table 2 across the temperament groups. Full details are available upon request. For the first of our primary analyses, we examined stress assessed in pre-K, 1st, and 2nd grades and externalizing assessed midway through 2nd, 3rd, and 4th grades. As shown in Table 3, Model 1, findings supported our hypothesis that the stress-externalizing problems association would be strongest for the high resistance-high unadaptability group. The model showed acceptable fit. The stress-externalizing association was significant for the risk profile group only. The $\Delta\chi^2$ test comparing the low resistance-low unadaptability, low resistance-high unadaptability, and high resistance-low unadaptability groups indicated there were no significant differences among the lower risk groups (Table 3, $\Delta\chi^2$ test A). Therefore, we compared those three groups with the risk profile group. That test indicated a significant decrement in fit when constraining all four groups to equality than when freeing the stress-externalizing path for the risk profile group (Table 3, $\Delta\chi^2$ test B). Thus, Model 1 supported our hypothesis that the stress-externalizing association would be strongest for children with high levels of both resistance and unadaptability.

Models 2 and 3 both examined stress assessed pre-kindergarten, 1st, and 2nd grades; externalizing was assessed during 4th, 5th, and 6th grades for Model 2 and during 6th, 7th, and 8th grades for Model 3. Model 4 used stress assessments from pre-3rd, 4th, and 5th grades and externalizing assessments from midway through 5th, 6th and 7th grades. Results of Models 2 – 4 provided strong support for our hypothesis. All three models showed acceptable fit, except the NFI was somewhat low for Models 2 and 3. The stress-externalizing path was significant for the high resistance-high unadaptability group only. There were no significant differences between the low resistance-low unadaptability, low resistance-high unadaptability, and high resistance-low unadaptability groups, and the $\Delta\chi^2$ tests comparing the risk profile group with the other groups were significant. Thus, our hypothesis was supported by Models 1-4.

In Model 5, we examined the association between stress in the window from pre-3rd to 5th grades and externalizing in the window from midway through 6th to 8th grades. Except for the NFI, the fit indices suggested acceptable fit to the data, and the stress-externalizing association was significant for the high resistance-high unadaptability group only. $\Delta\chi^2$ testing, however, suggested none of the temperament groups differed from each other, including the risk profile group. Thus, Model 5 only partially supported our hypothesis.

Moreover, in Model 6, in which we examined the stress-externalizing association with stress assessed in the window of pre-4th, 5th, and 6th grades predicting externalizing assessed midway through 6th, 7th, and 8th grades, we found little support for our hypothesis. Like several of the other models, this model showed acceptable fit except for the NFI. The regression coefficient for the stress-externalizing association was significant for the high resistance-high unadaptability group, but it was also significant for the low resistance-high unadaptability group, and $\Delta\chi^2$ tests revealed no significant differences between any groups.

To summarize, in every model, the association between stress and externalizing was significant for the high resistance-high unadaptability group. Furthermore, in every model except Model 6, this group had the largest stress-externalizing regression coefficient, and the coefficient was significantly larger for this group than for the other groups in four of the six models.[2] The interaction is depicted graphically in Figure 2; this figure depicts mean externalizing scores averaged across K through 8th grades for each of the four temperament groups. Stress scores were averaged across K through 8th grades, and split at the 75th percentile into high and low stress groups.

Secondary Analyses

Because of previous findings of higher rates of externalizing problems in males than in females (Webster-Stratton, 1996), we tested child sex as a moderator of the stress-externalizing association within the high resistance-high unadaptability group. We also tested for differences as a function of child race, which we re-categorized as either European American or non-European American, because very few children were both non-European American and non-African American. These tests were conducted using Model 1, because it was one of the models that provided particularly clear evidence of resistance and unadaptability strengthening the stress-externalizing association. The test of race as a moderator was non-significant, $\Delta\chi^2$ (1) = 1.02, $p > .05$. The test of sex as a moderator was significant, $\Delta\chi^2$ (1) = 6.21, $p < .05$. The stress-externalizing path was significant for males ($\beta = .65$, $p < .05$), but not for females ($\beta = .00$, $p > .05$). Therefore, we tested for sex differences in the temperament profile groups using χ^2 tests. There were no sex differences. These results provide limited evidence that among highly resistant, unadaptable children, boys might have stronger tendencies toward externalizing behavior in the context of stress than girls. The findings do not suggest, among resistant and

unadaptable children, that the association between stress and externalizing varies as a function of race, nor that temperament profile varies as a function of sex.

We also used latent growth modeling to provide an initial test of the possibility that resistance and unadaptability strengthen the association between the stress and externalizing slopes across all 9 years. We correlated the stress and externalizing indicators within each year and regressed each externalizing indicator on the stress indicator from the preceding year, and computed the model for the sample as a whole. Increasing stress predicted increasing externalizing ($\beta = .49$, $p < .001$). Next, we estimated this path separately for each group. The model provided a somewhat poor fit to the data, χ^2 (516) = 1005.51, $p < .001$, $\chi^2/df = 1.95$, RMSEA = .04, CFI = .85, NFI = .74. A $\Delta\chi^2$ test revealed no group differences in the stress slope-to-externalizing slope regression, $\Delta\chi^2$ (3) = 5.25, $p > .05$. Although the regression of the externalizing slope on the stress slope was significant for the high resistance-high unadaptability group ($\beta = .47$, $p < .05$), it was also significant for the low resistance-low unadaptability group ($\beta = .83$, $p < .001$). Thus, we found limited evidence that resistance and unadaptability moderate the association between stress and externalizing slopes.

Because of the possibility that the correct direction of effects is from externalizing to stress, rather than from stress to externalizing, we recomputed the latent growth model, testing the externalizing slope as a predictor of the stress slope. Although increases in externalizing predicted increases in stress for the sample as a whole ($\beta = .22$, $p < .05$), this association was not strengthened by high levels of resistance and unadaptability. Instead, the association was nonsignificant for the high resistance-high unadaptability group ($\beta = .15$, $p > .05$), but was significant for the low resistance-low unadaptability group ($\beta = .54$, $p < .05$). Thus, it does not appear that resistance and unadaptability strengthen the externalizing-to-stress association.

We also considered the possibility that temperament moderates the stress-externalizing association differently for different forms of stress. Consistent with research distinguishing between positive and negative stressors (Kanner, Feldman, Weinberger, & Ford, 1987), we identified potentially positive stress items (e.g., birth of a sibling, remarriage) and negative stress items (e.g., divorce) on the Changes and Adjustments Scale, and ran the models separately for positive and negative stress. We also identified stress items that reflect different conceptual categories of stress: family stress (parental separation or divorce, parent-TC separation), child medical problems or death of an important person, upheaval (e.g., moving, remodeling), and financial or legal stress. In general, the association between stress of any type and externalizing was strongest for highly resistant, highly unadaptable children. The main exception was for child medical problems or death of an important person, for which the association was strongest in the high resistance-low unadaptability group. Thus, overall, results of tests distinguishing between types of stress were consistent with our primary results. We also considered the possibility that the more distal financial or legal stressors influence externalizing through their effects on family stress. Thus, we tested a model in which the association between financial or legal stressors assessed in pre-K – 2nd grades and externalizing assessed midway through 6th – 8th grades was mediated by family stress assessed in pre-3rd – 5th grades. The path from financial or legal stress to family stress was significant for the low resistance-low unadaptability and high resistance-low unadaptability groups, and the path from family stress to externalizing was significant for the high resistance-high unadaptability group, but there was no evidence of mediation.

Discussion

Our results support the hypothesis that the association between exposure to family stress and externalizing problems would be strongest for children with a temperament profile of high levels of both resistance and unadaptability. For these children, the stress-externalizing association was significant in every model. Further, the association was significantly larger for these children than for children with other combinations of temperament dimensions in four of the six models. These results support our hypothesis that highly resistant, highly unadaptable children are particularly at risk for externalizing problems in the face of chronic family stressors.

How would family stress and resistant temperament lead to the development of more externalizing problems in unadaptable children than in adaptable children? We suggest that this would reflect a process involving high levels of general arousal (Newman & Wallace, 1993). The key question regarding this explanation is why unadaptable children—presumably disposed to anxiety—do not automatically inhibit their aggressive, disruptive, or rule-breaking behavior in the presence of the threat cues often present in situations that trigger such behavior?

Based on theory (e.g., Newman & Wallace, 1993; Wallace & Newman, 1997) and on the present findings, we propose that for a child predisposed to anxiety, stress paradoxically amplifies any tendencies the child has toward impulsive, aggressive behavior. We assume that the unadaptable child is predisposed to anxiety, so that during times of stress, such as parents' financial problems, the child's behavioral inhibition system (BIS) is activated, raising levels of nonspecific arousal. If such a child is also temperamentally resistant, then in many situations with incentives for approach behaviors, the high levels of arousal might increase the push for approach more than for inhibition. For example, an authority or a peer signals potential negative consequences for aggressive behavior, but the child fails to efficiently process this signal.[3]

Notably, resistance to control and unadaptability may both include strong emotion (approach and fearfulness, respectively) and difficulty with regulation. This suggests the possible interpretation that stronger links with externalizing may be due to the presence of strong emotion that the child has difficulty regulating, as suggested by a reviewer. Although this explanation could account for the additive main effects of either unadaptability or resistance, it cannot explain the interaction effect we found, in which there were stronger effects for children with high levels of both unadaptability and resistance than for children with high levels of one but not the other.

As a further speculation on how the resistance X unadaptability X stress effect may have come about, individual differences in psychophysiological reactivity might be important mechanisms underlying the interaction effect on externalizing (Beauchaine, 2001; Gunnar & Quevedo, 2007). Greater heart rate acceleration in novel contexts has been associated with temperamental inhibition (Fox, Henderson, Marshall, Nichols, & Ghera, 2005). Thus, increases in heart rate in response to stressors may be particularly strong in children with high levels of unadaptability. Further, heart rate reactivity to hypothetical peer conflict situations has been positively linked with antisocial behavior (Crozier et al., 2008). Thus, heart rate reactivity might be relevant for understanding the interaction we observed in the current study.

We found a significant association between stress and externalizing for males in the risk profile group, but not for females in the risk profile group. This finding might indicate that the theoretical model applies more strongly to males, which would have implications for the generalizability of the model. However, this finding does not indicate that sex moderates the 3-way interaction effect; rather, it indicates only that, among children high in both resistance and unadaptability, the stress-externalizing association is stronger for males than for females. With

only 58 females in the risk profile group, power to detect a significant association between stress and externalizing may have been limited. An alternative explanation may pertain to the greater variance of externalizing problems in males. Our finding may also indicate more vulnerability to stress in temperamentally at-risk boys than in girls. Notably, in contrast to these findings for sex, we found no evidence of differences as a function of child race.

We also found no evidence of sex differences in the temperament groups, which differs somewhat from previous findings. An extensive meta-analysis by Else-Quest, Hyde, Goldsmith, and Van Hulle (2006) revealed higher levels of self-regulation in females than in males, and a slight tendency for females to have higher levels of fearfulness than males. On that basis, it might be expected that there would be a higher representation of females in the low resistance-high unadaptability group, although such was not the case in our sample. Subsequent work should further examine the importance of gender differences for the theoretical model.

We also conducted initial tests of whether the association between stress and externalizing growth curve slopes is moderated by resistance and unadaptability. We found limited evidence of this. We can think of several possible explanations for not finding stronger evidence. The explanation we think is most likely is that the time lags reflected in our measurement are not the ideal ones for examining this interaction (Dwyer, 1983). The theoretical work of Newman and Wallace (1993, Wallace & Newman, 1997) suggests that stress causes dysregulation over a very short time scale. Our measurement, in contrast, reflects much less immediate processes, both in terms of the time lag between the occasions of measurement of stress and externalizing (a minimum of several months) and in terms of the assessment periods for these measures, with mothers reporting on stress occurring over the preceding year and teachers reporting on externalizing observed over approximately 6 months. Although we chose

to examine chronic stress based on previous research, it may be that examination of faster processes would be needed in order to observe an interaction effect on change in externalizing.

An alternative interpretation of the latent growth results is that the correct direction of effects is from child externalizing to stress, with the combination of high resistance and high unadaptability strengthening this path, rather than strengthening the path from stress to externalizing. However, latent growth modeling suggested that this is not the case, as the externalizing-to-stress path was non-significant for the risk profile group. Another possible explanation of the results is that stress does not cause increased externalizing for highly resistant, unadaptable children, but instead, a third variable might cause both stress and externalizing, with such links potentially being strengthened by resistance and unadaptability. In any case, conclusions about possible explanations for our latent growth model results must await further testing, using additional samples and additional measures—particularly ones measuring at a fine-grained temporal level. The current study suggests the potential value of such studies.

There are a number of limitations of the present study. First, several models showed somewhat marginal fit, based on the NFI (but not the other fit indices). Thus, further research will be needed to determine whether our findings can be replicated with other samples. In addition, our measures of child nonspecific arousal, approach, and inhibitory systems are indirect, and in terms of explaining developmental processes, it would be better to also include more direct measures. There are also many ways to assess stress. Using parent report of potentially stressful life events is one standard way, but there are others, such as measuring daily hassles. We also did not include autoregressive controls for earlier stress or externalizing. To our knowledge, the theory-based conceptualization that high resistance to control and high unadaptability would strengthen the association between stress and subsequent externalizing has

not previously been tested. Therefore, rather than asking the more complex question of whether a temperament profile moderates the association of early stress with later externalizing while controlling for stress and externalizing at other time points, we focused on the simpler question of whether the temperament profile moderates the association of stress with later externalizing.

The approach of examining how the combination of resistance, unadaptability, and stress predicts externalizing problems provides a more complete, accurate, and representative account of stress-externalizing links than can be provided by examining only one dimension of temperament at a time. Moreover, understanding temperament-related individual differences is crucial for identifying which children are likely to be resilient when encountering stressors, and which children are likely to need help. The finding that the children with high levels of both resistance and unadaptability have a stronger connection between stress and externalizing has implications for the identification of children at special risk for adjustment problems when exposed to stress. At the same time, this study is just a first step in this direction. Future studies should build on this study by examining change processes. However, a more pressing question is whether the phenomenon described here is a robust one. The pattern of results, with some replications across ages, is fairly compelling. However, this is just one study, and we believe that interaction effects are particularly crucial to replicate (Bates et al., 1998).

For the time being, however, we have a complex, but theoretically expected pattern of results. It appears that stressful family environments are more likely to be translated into externalizing behavior problems for children who are high in unadaptability and resistance to control than for those who are low on either or both of these temperament dimensions. We interpret the pattern as due to greater activation of the nonspecific arousal system in highly

anxious, highly resistant children in highly stressful environments, which amplifies their aggressive tendencies and impedes learning self-modulation skills.

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Table 1

Means, Standard Deviations, and Intercorrelations Among the Variables

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1 R	--																			
2 U	.19***	--																		
3 Stress-K	.01	-.03	--																	
4 Stress-1st	.06	.02	.31***	--																
5 Stress-2nd	.08	-.05	.30***	.55***	--															
6 Stress-3rd	.13**	.08	.16***	.38***	.46***	--														
7 Stress-4th	.11*	-.01	.21***	.43***	.44***	.53***	--													
8 Stress-5th	.05	.00	.21***	.28***	.49***	.45***	.44***	--												
9 Stress-6th	-.02	-.03	.20***	.36***	.41***	.37***	.43***	.51***	--											
10 Stress-7th	.07	-.01	.14**	.29***	.34***	.28***	.43***	.35***	.52***	--										
11 Stress-8th	.09	.07	.12*	.24***	.27***	.25***	.29***	.28***	.35***	.47***	--									
12 EXT-K	.12**	-.05	.03	.12**	.10*	.11*	.12*	.11*	.12*	.11*	.13**	--								
13 EXT-1st	.18***	-.04	.04	.07	.15**	.13**	.11*	.09	.12*	.11*	.13**	.57***	--							
14 EXT-2nd	.10*	-.12**	.07	.08	.19***	.09	.09	.12*	.13**	.09	.11*	.55***	.58***	--						
15 EXT-3rd	.11*	-.13**	.01	.10*	.13**	.12*	.11*	.06	.19***	.10*	.13**	.52***	.58***	.62***	--					
16 EXT-4th	.18***	-.09*	.06	.12*	.16***	.15**	.16**	.18***	.26***	.21***	.24***	.51***	.57***	.58***	.65***	--				
17 EXT-5th	.11*	-.04	.02	.08	.16**	.14**	.13*	.14**	.21***	.19***	.20***	.47***	.50***	.58***	.55***	.63***	--			
18 EXT-6th	.14**	.00	.02	.04	.12*	.07	.06	.12*	.17***	.12*	.15**	.40***	.40***	.46***	.48***	.52***	.54***	--		

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
19 EXT-7th	.10*	-.07	.00	.08	.09	.09	.09	.09	.11*	.11*	.21***	.42***	.37***	.41***	.53***	.52***	.61***	.51***	--	
20 EXT-8th	.11*	-.08	.01	.06	.15**	.02	.07	.14*	.12*	.03	.16**	.31***	.36***	.49***	.50***	.57***	.47***	.47***	.53***	--
M	3.58	2.99	2.35	2.65	2.64	2.61	2.51	2.35	2.41	2.47	3.63	5.86	6.61	7.10	6.60	6.72	7.22	7.07	6.68	7.80
SD	1.12	1.09	1.65	2.17	2.14	2.30	2.17	2.15	2.20	1.20	2.42	8.81	9.69	10.54	10.20	10.22	10.19	10.50	9.81	11.60

Note. *N*s range from 325 to 556. R = Resistance. U = Unadaptability. EXT = Externalizing. K = kindergarten. Numbers following "Stress" and "EXT" indicate grade level.
*$p < .05$, **$p < .01$, ***$p < .001$.

Table 2

Main Effects of Stress on Externalizing Problems

	Model 1 Str: K-2 EXT: 2-4	Model 2 Str: K-2 EXT: 4-6	Model 3 Str: K-2 EXT: 6-8	Model 4 Str: 3-5 EXT: 5-7	Model 5 Str: 3-5 EXT: 6-8	Model 6 Str: 4-6 EXT: 6-8
β	.21**	.20**	.15*	.20**	.16*	.24***
Factor loadings						
1st stress indicator	.39^f	.40^f	.40^f	.74^f	.74^f	.61^f
2nd stress indicator	.74***	.73***	.75***	.73***	.73***	.73***
3rd stress indicator	.73***	.74***	.72***	.62***	.62***	.71***
1st EXT indicator	.75^f	.79^f	.68^f	.81^f	.68^f	.69^f
2nd EXT indicator	.83***	.81***	.78***	.70***	.79***	.78***
3rd EXT indicator	.79***	.71***	.69***	.78***	.69***	.69***
Fit indices						
χ^2 (*df*=8)	11.56	6.42	9.19	3.21	7.41	6.52
χ^2/df	1.45	.80	1.15	.40	.93	.82
RMSEA	.03	.00	.02	.00	.00	.00
CFI	1.00	1.00	1.00	1.00	1.00	1.00
NFI	.98	.99	.98	.99	.99	.99

Note. β = standardized coefficients for stress-externalizing path. Str = Stress; 1st stress indicator = first manifest stress indicator for the particular window; 2nd stress indicator = second manifest stress indicator; 3rd stress indicator = third manifest stress indicator. 1st EXT indicator = first manifest externalizing indicator; 2nd EXT indicator = second manifest externalizing indicator; 3rd EXT indicator = third manifest externalizing indicator. ^{f} denotes factor loadings fixed for model estimation purposes.

*p < .05, **p < .01, **p < .001.

Table 3

Interaction Effects of Temperament and Stress on Externalizing

	Model 1 Str: K-2 EXT: 2-4	Model 2 Str: K-2 EXT: 4-6	Model 3 Str: K-2 EXT: 6-8	Model 4 Str: 3-5 EXT: 5-7	Model 5 Str: 3-5 EXT: 6-8	Model 6 Str: 4-6 EXT: 6-8
Parameter estimates						
$\beta_{lowR\text{-}lowU}$	.12	.15	.08	.07	.01	.22
$\beta_{lowR\text{-}highU}$	.15	.08	.16	.11	.29	.39*
$\beta_{highR\text{-}lowU}$	.21	.14	.06	.05	-.02	.10
$\beta_{highR\text{-}highU}$	.44**	.42**	.37*	.40***	.36**	.33*
Fit indices						
χ^2 (*df*=44)	60.79*	82.02***	76.25**	58.12	68.41*	71.52**
χ^2/df	1.38	1.86	1.73	1.32	1.55	1.63
RMSEA	.03	.04	.04	.02	.03	.03
CFI	.98	.94	.93	.98	.95	.94
NFI	.92	.88	.86	.91	.88	.87
$\Delta\chi^2$ test A (Δdf=2)	1.06	.43	.19	.09	2.44	1.44
$\Delta\chi^2$ test B (Δdf=1)	5.96*	5.95*	4.13*	6.24*	3.59	.48

Note. Fit indices are from unconstrained model. Str = stress. EXT = externalizing. β = standardized coefficient for stress-externalizing path. R = Resistance to control. U = Unadaptability. $\Delta\chi^2$ test A compares model in which lowR-lowU, lowR-highU, and highR-lowU groups are constrained to equality with unconstrained model. $\Delta\chi^2$ test B compares model in which all groups are constrained to equality with model in which lowR-lowU, lowR-highU, and highR-lowU groups are constrained to equality and highR-highU group is free to vary.

*p < .05, **p < .01, **p < .001.

Figures

Figure 1. Graphical Depiction of Models Tested. The model number indicates which model tests associations between the corresponding stress and externalizing assessments. K = kindergarten. pre = beginning school year. mid = midway through school year.

Figure 2. Mean Externalizing Scores Summed Across K Through 8th Grades for Each of the Four Temperament Groups Sub-divided Based on High and Low Stress. Stress scores were averaged across K through 8th grades, and split at the 75th percentile. Low/Av. Stress = Mean K – 8th grade stress scores below 75th percentile. High Stress = Mean K – 8th grade stress scores at or above 75th percentile. R = Resistance to control. U = Unadaptability.

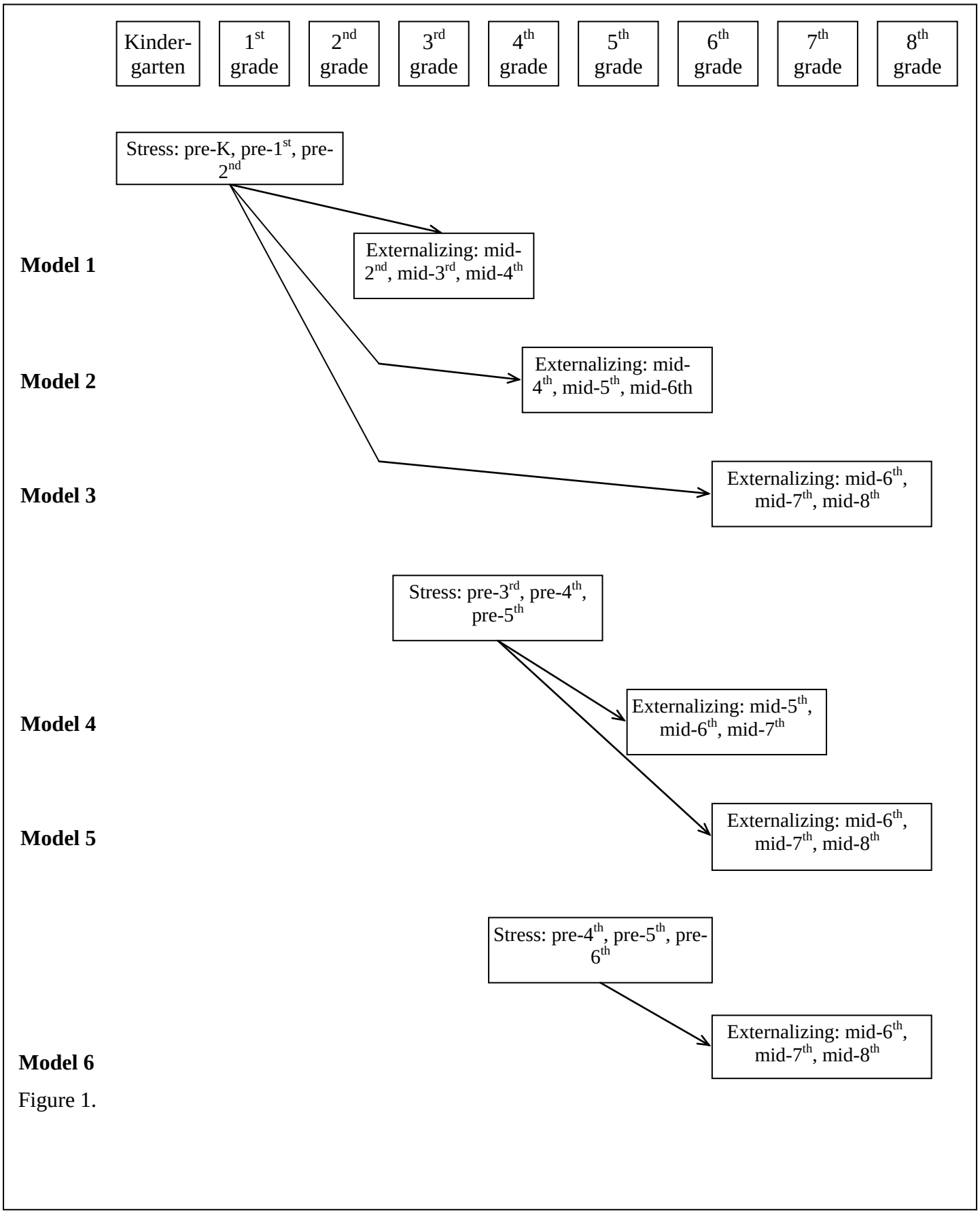
Kinder-garten
1st grade
2nd grade
3rd grade
4th grade
5th grade
6th grade
7th grade
8th grade
Model 1
Stress: pre-K, pre-1st, pre-2nd
Externalizing: mid-2nd, mid-3rd, mid-4th
Model 2
Externalizing: mid-4th, mid-5th, mid-6th
Model 3
Externalizing: mid-6th, mid-7th, mid-8th
Model 4
Stress: pre-3rd, pre-4th, pre-5th
Externalizing: mid-5th, mid-6th, mid-7th
Model 5
Externalizing: mid-6th, mid-7th, mid-8th
Model 6
Stress: pre-4th, pre-5th, pre-6th
Externalizing: mid-6th, mid-7th, mid-8th

Figure 1.

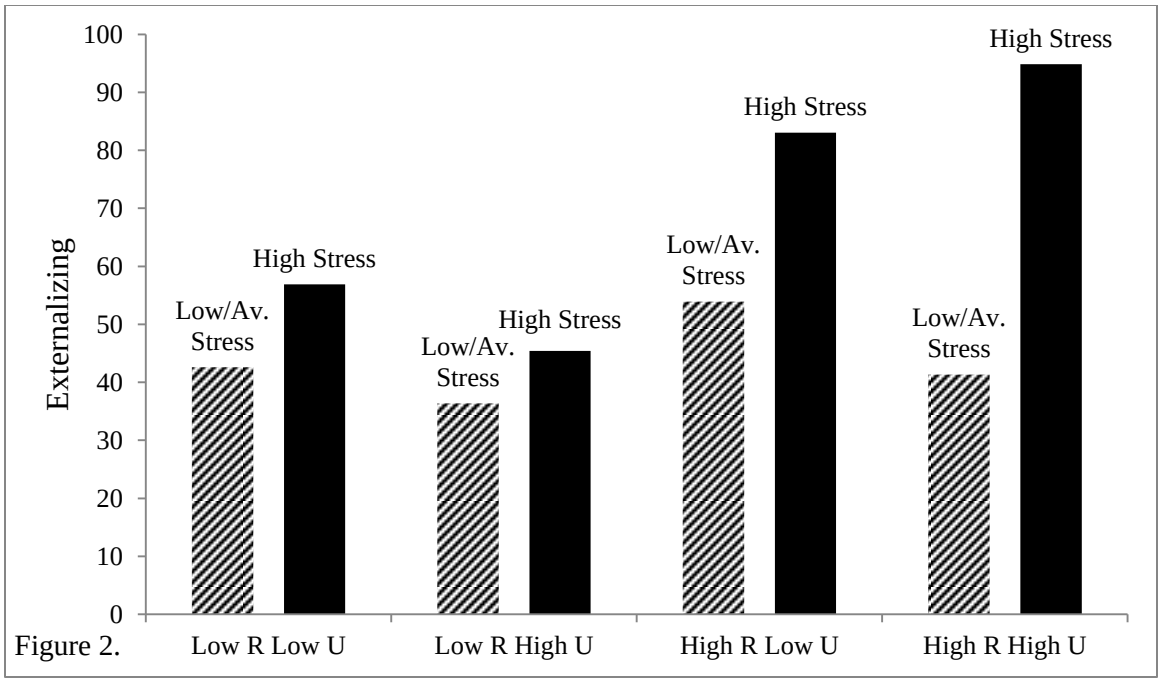
Externalizing
100
90
80
70
60
50
40
30
20
10
0
Low/Av. Stress
High Stress
Low/Av. Stress
High Stress
Low/Av. Stress
High Stress
Low/Av. Stress
High Stress
Low R Low U
Low R High U
High R Low U
High R High U

Figure 2.