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# Variable- and Person-Centered Approaches to Examining Temperament Vulnerability and Resilience to the Effects of Contextual Risk

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## Abstract

Using both variable- and person-centered approaches, this study examined the role of temperament in relation to children's vulnerable or resilient responses to cumulative risk. Observed reactivity and regulation dimensions of temperament were tested as mediating and moderating the relation between family cumulative risk and teacher-reported adjustment problems in a sample of 259 preschool-age children. Further, latent profile analyses were used to examine whether profiles of temperament, accounting for multiple characteristics simultaneously, provided additional information about the role of temperament in children's responses to risk. Results support a diathesis-stress model in which high frustration, low fear, and low delay ability confer particular vulnerability for children in high-risk contexts. Benefits of multiple approaches are highlighted.

## 1. Introduction

Low income has consistently been found to relate to increased risk for psychopathology, maladjustment, and negative health outcomes and has specifically been shown to predict greater adjustment problems in children (Bradley & Corwyn, 2002; Duncan, Ziol-Guest, & Kalil, 2010; Lengua & Wachs, 2012). The effects of low income, however, are in part accounted for by association with a broader context of risk, including greater experience of stress, residential instability, neighborhood problems, family conflict and disorganization, parental mental health problems, and numerous other risk factors that often co-occur. This co-occurrence of risk impacts children's development through exposure to a heavier burden of adversity disproportionately experienced by lower income families compared to higher income families and may account for the effects of low income on child adjustment (Lengua, 2002; Lengua, Moran, Zalewski, Ruberry, Kiff, & Thompson, 2015). Aggregation of co-occurring risk factors, or cumulative risk, allows for testing ecological models that jointly consider demographic, psychosocial, and environmental risk (Evans, 2003), the joint impact of which may not be fully captured by income level alone. For instance, cumulative risk has been found to relate to increases in children's internalizing and externalizing problems above and beyond the effects of socioeconomic risk (Lengua, Bush, Long, Kovaks, & Trancik, 2008). Despite consistent evidence supporting the corrosive effects of cumulative risk on children's adjustment, exposure to contextual risk does not definitively undermine development (Kim-Cohen, Moffitt, Caspi, & Taylor, 2004). The developmental impact of contextual risk depends on a number of factors, including individual child characteristics, such as temperament, which may contribute to differential outcomes, either vulnerability or resilience, in response to risk. This study examined the potential mediating and moderating roles of temperament in accounting for the effects of cumulative risk on child adjustment utilizing both variable- and person-centered approaches. This study clarifies both the potential mechanisms of the effects of temperament and the possible interplay of multiple temperament characteristics.

### 1.1 Temperament

Temperament is often defined as biologically based individual differences in reactivity and self-regulation that are typically expressed as response differences in intensities, latencies, durations, thresholds, and recovery times. These individual differences appear in the first few years of life and remain relatively stable over time, but may be influenced by heredity, maturation, socialization and contextual experience (Rothbart, Ahadi, & Hershey, 1994; Zentner & Bates, 2008). More specifically, reactivity refers to the arousability of affect and excitability of motor responses and includes, among others, reactivity to fear and frustration. Although often studied as a single construct (i.e., negative reactivity), limited research has found unique effects of fear and frustration as they relate to children's adjustment (Clifford, Lemery-Chalfant & Goldsmith, 2015; Eisenberg et. al, 2001; Lengua, 2008; Moran, Lengua, & Zalewski, 2013). Fear reactivity is described as the propensity to experience negative affect, inhibition, or withdrawal in response to novel or challenging situations. Frustration, also referred to as anger or irritability, is distress to limitations, experiences of failure, having a goal blocked, or to the interruption of an ongoing task. Fear and frustration reactivity are frequently distinguished by relations to motivational systems reflecting sensitivity to reward or punishiment. Specifically, fear reactivity has been linked to activation of the behavioral inhibition system (BIS), which produces inhibition of ongoing behavioral programs, increased sympathetic activity, heightened attention to relevant or novel stimuli in the environment, and subsequent defensive and withdrawal behaviors typical of fear reactions (Kagan, 2013). In contrast, frustration reactivity, particularly in response to competition for resources and removing a frustrating obstacle, is linked to the behavioral activation system (BAS) resulting in appetitive and reward seeking behaviors and offensive aggression (Deater-Deckard & Wang, 2012; Depue & Iacono, 1989). As fear and frustration appear to reflect distinct processes, they may confer differential risk for the development of problems and may interact with contextual risk in unique ways.

Regulatory components of temperament, most often conceptualized as effortful control, refer to processes that serve to alter emotion reactivity through mechanisms like executive control and ability to delay gratification (Rothbart & Derryberry, 1981). Executive control, which is defined as the capacity to inhibit a dominant response in favor of initiating a more adaptive, subdominant response. It is a later appearing component of temperament than the more reactive characteristics and has been linked to positive adjustment (Eisenberg et al., 2004; Murray & Kochanska, 2002; Lengua, 2006; Lengua et al., 2008; Rothbart & Bates, 2006). The ability to delay gratification is the capacity to tolerate deferring immediate reward or the speed of response initiation and is specifically tapped when the regulation of affect and motivation is necessary for successfully navigating emotionally evocative contexts (Mischel & Ayduk, 2011). Although these two components of effortful control are necessarily related and work as an integrated system (Rothbart & Bates, 2006), they also appear to differ in related neural activity, developmental course, antecedents, and relations to adjustment (e.g., Hongwanishkul, Happaney, Lee, & Zelazo, 2005; King, Lengua & Monahan, 2013).

Both reactive and regulatory components of temperament have been identified as important predictors of children's adjustment (Lengua, 2002; Liew, Eisenberg, & Reiser, 2004; Muris & Ollendick, 2005), and additionally predict adjustment over and above the effects of contextual risk (e.g., Corapci, 2008; Lengua, 2002). Thus, temperamental characteristics may independently, either in isolation or in combination with additional risk factors, impact adjustment. Beyond direct effects, temperament dimensions may interact suggesting the impact of one dimension of temperament is likely to depend, in part, on the presence and strength of other dimensions within an individual's profile (Zentner & Bates, 2008). Specifically, effortful control may moderate the relation between high reactivity and maladjustment, with high regulation acting as a buffer to provide the capability to modulate emotion reactivity or behavioral responses to reactivity, and subsequently reduce the risk of psychopathology. In contrast, highly-reactive children with lower regulation may experience an intensity of negative emotion that overwhelms the deficient regulatory system leading to unchecked approach or avoidance reactions, and less flexible or less effective strategies for coping with stressors (Muris & Ollendick, 2005). Less reactive children, however, may not require as strong of a regulatory system to control affect and behavior, remaining resilient even at lower levels of self-regulation. Prior research has found support for effortful control acting as a protective factor by buffering the impact of high negative emotionality on problems in relation to children's internalizing and externalizing problems (Gartstein, Putnam, & Rothbart, 2012; Lawson & Ruff, 2004; Muris, 2006), as well as social competence (Eisenberg, Fabes, Guthrie, & Reiser, 2000). Thus, effortful control may be particularly important for children with high negative reactivity.

### 1.2 Risk, Temperament, and Adjustment

Temperament may contribute to or alter the effect of cumulative risk on children's adjustment either through mediation or moderation processes. Mediation would suggest that income related risk might shape or alter development and expression of children's temperament, particularly in young children, which may then subsequently increase children's risk for maladjustment. In this way, individual differences in temperament dimensions may account, at least in part, for the relation between risk and adjustment. Supporting this, low income, exposure to more sociodemographic and residential stressors, and cumulative risk were shown to relate to children's lower executive control and higher negative reactivity, both of which, in turn, predict poorer adjustment outcomes (Lengua &

Wachs, 2012; Li-Grining, 2007; Raver, 2004). Additionally, cumulative risk has been found to disrupt children's development of delay ability, which accounted for some of the effect of risk on children's adjustment (Lengua et al., 2015). Therefore, exposure to risk may shape the nature and course of temperament leading to higher rates of problem behavior, and thus, indirectly relate to adjustment through its effect on temperament dimensions.

In addition to mediated pathways, individual differences in temperament may moderate the effect of contextual risk on adjustment, with certain characteristics serving to either mitigate or exacerbate the impact of risk. Significant moderation by temperament suggests that the influence of risk on children's adjustment depends on the relative strength of various temperament dimensions. Several different models have posited moderating effects of temperament, specifically differential reactivity and differential susceptibility or biological sensitivity to context models.

The differential reactivity model suggests that children's responses to the same contextual factors may vary based on individual differences in temperament (Wachs, 1992). This model is consistent with both diathesis-stress models and vulnerability models, allowing for temperament to relate to children's response to risk in different ways. For instance, high emotion reactivity may increase children's vulnerability to the stress and unpredictability of living in a low-income environment, resulting in poorer adjustment than less reactive children in the same context (Comas, Valentino, Bridgett, & Hayden, 2014; Wachs, 2006). Additionally, effortful control may protect or buffer children from risk, contributing to their resilience in response to risk. For example, prior research has found that children with low effortful control living in high risk contexts showed poor adjustment, but those with high effortful control demonstrated equivalent adjustment to children living in low risk contexts (Flouri, Midouhas, & Joshi, 2014; Lengua, 2002). This pattern would be consistent with a diathesis-stress model where temperamental risk factors act as a diathesis within the context of stress associated with low income. Conversely, certain temperament characteristics may relate to poorer adjustment regardless of context. In the absence of temperamental risk, in contrast, children's adjustment then depends on exposure to contextual risk. This alternative pattern of interactions between temperament and risk is consistent with a vulnerability model (Lengua & Wachs, 2012) and prior research has found evidence for this pattern in interactions between children's frustration, neighborhood risk, and social competence (Bush, Lengua, & Colder, 2010).

Although negative reactivity may increase vulnerability to maladjustment in disadvantaged contexts, it is also possible that higher reactivity confers additional benefits in low-risk contexts. High reactive children may be more susceptible to both negative and positive contexts, such that in the presence of positive contextual influences, highly reactive children may demonstrate better adjustment than low reactive children. Patterns of association in this manner would support differential susceptibility and biological sensitivity to context models suggesting that interpretation of certain temperament characteristics as either risky or beneficial depends on environmental context (Belsky & Pleuss, 2009; Boyce & Ellis, 2005). Evidence from prior research exploring interactions between temperament and contextual risk factors have been mixed in their support of either differential reactivity or differential susceptibility models (for summaries see: Lengua & Wachs, 2012; van IJzendoorn &

Bakermans-Kranenburg, 2012). In the current study, the observed patterns of interactions between temperament and risk were assessed with attention to their consistency with these various theoretical models.

Complex models accounting for both reactivity and regulation simultaneously are needed to understand the dynamic interactions between individual characteristics and the impact of risky environments on children's adjustment. For instance, high effortful control may buffer the negative effect of high reactivity in high-risk contexts. As such, 3-way interactions among cumulative risk, reactivity and self-regulation may elucidate important pathways to children's positive or negative adjustment in the face of adversity. Another approach to examining reactivity and regulation simultaneously is a profile or person-centered analysis.

### 1.3 Profile Approach

Testing 3-way interactions between temperament and risk employs moderation techniques in a regression model and explores these relations from a variable oriented approach. A variable approach focuses on the relations among cumulative risk, reactivity, and regulation and their relative contributions to predicting children's adjustment outcomes. Person-oriented methods, alternatively, can describe the patterning of multiple variables within individuals to capture essential features of responding that may be lost when simple linear associations are analyzed. This may allow for the examination of the contribution of a specific combination of variables, or intraindividual arrangement of temperament characteristics, to some outcome (e.g., Bergman, 2002; Meeus, Van de Schoot, Klimstra, & Branje, 2011). We used person-oriented analysis—latent profile analysis (LPA; Muthén, 2001)—to capture profiles of temperament reactivity and self-regulation. LPA classifies individuals who are similar on several observed variables, with the assumption that the patterns of values are determined by a latent variable. With LPA, each individual receives a probability for being a member of each profile that is identified, therefore allowing for identification of their most likely classification and avoiding the use of arbitrary cut-points between classifications. These probabilities can then be linked to other variables that might predict or result from the particular styles of reactivity and regulation. For instance, different configurations of personality profiles, including Big Five traits, in adolescence have been associated with varied risk for anxiety and difficulties in relationships (Meeus et al., 2011). In younger children, person-oriented approaches often focus on temperament profiles including emotion reactivity or approach tendencies, but frequently exclude self-regulation (e.g., exuberant vs. inhibited children; Stifter, Putnam, & Jahromi 2008). Very few studies include multiple characteristics of temperament, tapping different aspects of both reactivity and regulation (Derauf et al., 2011). In this study, we used objective measures of fear reactivity, frustration reactivity, executive control and delay ability to model the joint contributions of multiple temperament characteristics to children's vulnerable or resilient responses to risk.

### 1.4 Current Study

The current study examines whether the association of cumulative risk with adjustment problems can be accounted for by the mediating or moderating effects of temperament during the preschool period, a developmental period that captures rapid growth in effortful control as well as the emergence of adjustment problems. In prior research, low income and cumulative risk have been found to predict altered growth of dimensions of effortful control during this developmental period (Lengua et al., 2015), supporting the importance of examining these relations early in children's development. Previous studies examining the mediating or moderating effects of temperament in relation to risk have tended to study older children with few studies examining these relations in the critical preschool-age period. Also, few previous studies examined mediating and moderating effects in the same study.

Additionally, multiple dimensions of both negative reactivity (i.e., fear and frustration) and effortful control (i.e., executive control and delay ability) were tested to explore differential relations with contextual risk and children's adjustment. By testing 3-way interactions among reactivity, regulation, and risk, we explored whether temperament dimensions interact with each other in their moderation of risk. Beyond traditional variable-centered approaches, a profile approach was also tested using latent profile analysis to explore how temperament profiles, which capture shared attributes within groups of children, may relate to contextual risk, predict adjustment, and moderate the relation between risk and adjustment. Through approaching temperamental vulnerability and resilience to risk from both a variable and profile approach, we are able to assess whether person-centered approaches increase our understanding or ability to capture the effects of multiple temperament dimensions on adjustment. Accounting for complex, multi-dimensional models of temperament allow us to explore how effortful control and negative reactivity interact (e.g., variable interactions) or work in combination (e.g., profiles) to alter relations between contextual risk and children's development. This study contributes to our understanding of the role of temperament in children's vulnerable or resilient responses to cumulative risk, elaborating how negative reactivity and effortful control might operate simultaneously in a complex manner in predicting children's adjustment.

## 2. Methods

### 2.1 Participants

Study participants were 259 mothers and their 36 month-old children ($M = 37.00$, $SD = 0.84$ mos.) who were part of a larger study of 306 families recruited from various public- and privately-funded sources, including daycares, preschools, libraries, health clinics, and charitable agencies and organizations serving low income families (e.g., county-sponsored “play and learn” groups for mothers and children, food banks, *Catholic Community Services)*. Families at these sites received information forms about the study and could indicate their interest in participating in the study on the information forms returned through their organization or mailed directly to the research project in postage paid envelopes. Recruitment sites received an honorarium of $100.00 when 90% or more of their families returned the forms, regardless of the number of families indicating interest in participating. If a site returned 75% or 50% of the forms, the site received $75.00 or $50.00, respectively.

Families were recruited for participation to create equal representation across income levels. The sample was roughly evenly distributed across income levels, with 29% of the sample at or near poverty (N = 90 at or below 150% of the federal poverty threshold), 27% low income

(N = 83 below the local median income of $58K), 25% middle income (N = 78 above the median income to $100K), and 18% upper income (N = 54 above $100K). To participate, reasonable proficiency in English to comprehend the assessment procedures was required, and children diagnosed with a developmental disability were excluded. Participants included 50% girls. The racial and ethnic composition of the sample of children included 64% European American, 9% African American, 3% Asian American, 10% Latino or Hispanic, 2% Native or American Indian, and 12% multiple racial and ethnic backgrounds or other. The distribution of mothers' education level included 3% with some high school attainment, 6% completed high school, 34% with some college, technical school or professional school, 30% college graduates, and 27% with post-graduate education. The majority of mothers were married or had long time partners (81%), 12% were never married, 7% were separated, divorced or widowed and were the single heads-of-household.

## 2.2 Procedures

Families were assessed in research offices on the university campus on four occasions, each separated by 9 months. Data for this study are taken from the 1st and 3rd assessments, referred to as T1 and T2 in this paper. These two assessments were separated by approximately 18 months, allowing examination of the effects of temperament on relative changes in adjustment problems. At the beginning of each assessment, following the guidelines stipulated by the Social and Behavioral Sciences Institutional Review Board at the University of Washington, both active parental consent and child assent were secured prior to data collection. To minimize bias due to shared method variance and to provide a more rigorous test of our hypotheses, this study leveraged multi-method assessments, including neuropsychological, task performance, physiological, and questionnaire measures administered by a team of trained experimenters. Children were administered emotion eliciting and effortful control tasks described below while mothers completed questionnaire measures in a separate room. Families were compensated $70 for their first visit with compensation increasing by $20 for each subsequent visit. Teachers were then asked to complete behavior rating scales on study children and were compensated $15 for completing the questionnaires.

## 2.3 Measures

**2.3.1 Income and demographics—**Demographic questions completed by the parent at time 1 included child's race and ethnicity, income, and parent education. Mothers reported on household income from all sources on a 14-point Likert scale that provided a fine-grained breakdown of income at the lower levels facilitating identification of families at the federal poverty cutoff using an income to means ratio (e.g. 1 = $14,570 or less, 2 = $14,571-$18,310, 3 = $18,311-22,050, etc.). However, the 14-point variable representing the full range of income was used for analyses (M = 8.75, *SD* = 3.93, *Range* = 1.00 – 14.00, 8 = $35,601-$39,200).

**2.3.2 Cumulative family risk—**Cumulative risk included eight factors representing demographic (low maternal education, single parent status, adolescent parent), contextual (residential instability, household density), and psychosocial (negative life events, parental divorce, maternal depression) risk. The correlations among the risk factors (Table 1) ranged from .01 to .50 in magnitude indicating that they were related but not redundant.

**2.3.2.1 Demographic Risk:** Mothers reported on their educational attainment. Risk was indicated by mothers' not graduating from high school, with 3% of mothers meeting this criterion. Mothers reported on their marital status, and families were identified as single parent families if the mother indicated she was never married, currently widowed, separated or divorced, or living for less than one year with a live-in partner, with 19% of mothers meeting these criteria. Mothers reported their age at the time of the study child's birth, and 3% of the mothers were considered an adolescent parent given that they were 19 years or younger when the child was born.

**2.3.2.2 Contextual Risk:** Residential instability was indicated by the family changing households three or more times in the previous thee years, encompassing the majority of the child's lifetime, and 10% of the children experienced three or more moves. Household density was calculated as the number of individuals living in the family home divided by the number of total rooms (kitchen, dining, living, family, bed and bathrooms) in the family home. The average ratio was .52, indicating that on average, there were twice as many rooms in the house as there were individuals living in the home. The score was converted to a proportion of the highest score in the sample.

**2.3.2.3 Psychosocial Risk:** Negative life events were assessed with parent report on the General Life Events Schedule for Children (Sandler, Ramirez & Reynolds, 1986), previously shown to have significant associations with child adjustment (Lengua & Long, 2002). The 29 events include a range of moderate to major negative events including changing schools, death of a family member or friend, parental arrest, loss of friends or pets. Parents reported the occurrence of events within the previous 9 months, and total scores were the number of events that occurred. The average number of negative life events was 5.3 (*SD* = 4.0; *Range* = 0 - 26). The total score was converted into a proportion of the possible 29 events. Family structure transitions were indicated by mothers reporting being divorced in the child's lifetime and occurred in 3% of the families. Mothers reported on their own depressive symptoms over the previous month using the 20-item Center for Epidemiological Studies–Depression Scale (CES-D, Radloff, 1977), a widely used self-report scale designed to measure depressive symptoms in the general population. Participants indicate whether each symptom was present on a scale of 0 (*rarely or never*) to 3 (*most of the time*), and the items were summed for a total score, with higher scores indicating higher levels of depression. Internal consistency of .89 has been reported and was .88 in this study. The average score in this sample was 10.02 (*SD* = 8.39, *Range* = 0 - 46.67), with a clinical cut-off of 16. The total score was converted into a proportion of the total possible score of 60.

**2.3.2.4 Total Cumulative Risk Score:** A total cumulative family risk score was the sum of all of the component factors, described in detail below. Dichotomous risk factors were scored 0 = *not present*, 1 = *present*. Continuous risk factor scores were converted into proportions of the total possible score so that they ranged from 0 to 1, and thus, were weighted equally with the dichotomous variables without loss of their continuous scale. The average cumulative risk score was 1.01 (*SD* = .83; *Range* = 0 - 4.6). The cumulative risk score intends to capture the added impact of co-occurring risk factors indicating the burden of stress frequently experienced by children in low-income families. An indicator of family income was not included in the cumulative risk score, but was included as a covariate in all analyses to account for limited financial resources outside of this added burden of stress. Segregating income from the indicator of risk allows for explicit assessment of how temperament characteristics relate to children's development in the context of accumulated risk above and beyond just the impact of family financial resources.

**2.3.3 Temperament—**Objective measures of negative reactivity (fear and frustration) and effortful control (executive control and delay ability) were obtained. Observation of children's reactivity to emotion eliciting tasks were used to measure children's fear and frustration reactivity. These tasks were adapted from the Laboratory Temperament Assessment Battery, which is a standardized instrument for assessment of temperament in children 3-5 years of age (Goldsmith, Reilly, Lemery, Longley, & Prescott, 1995). Effortful control was assessed using behavioral measures of executive control and delay ability (e.g., Kochanska, Murray, & Harlan, 2000; Li-Grining, 2007). Emotional and behavioral responses to the tasks were later rated by coders unfamiliar with the children and hypotheses of the study. In addition to the initial coding, 20% of taped responses were coded by a second rater to assess for inter-rater reliability.

**2.3.3.1 Fear Reactivity:** Fear was assessed by observed fear expressions and behaviors to a scary object. Children were prompted to touch a toy spider triggered to jump when the child approached it. Child behaviors were coded for intensity of a fear response ranging from 0 (*no observed response*) to 2 (*obvious, strong response*). Coded behaviors included body motions (e.g., jumping/withdrawing, shaking/fluttering), facial expressions (e.g., widened eyes, tensing face), and vocalizations (e.g., non-language noises, verbal refusals). An overall fear score for each prompt was assigned based on the number of behaviors coded. In addition, latency to touch the spider after the prompt was given was assessed, with potential latencies ranging from 0 to 5 seconds. Total scores were the average overall rated fear across three prompts that also took into account the latency for the child to touch the spider. Internal consistency of the fear scale was .89, and the inter-rater ICC, based on double coding of 20% of cases, was .97.

**2.3.3.2 Frustration Reactivity:** Frustration was assessed by observed distress to a blocked goal, in this case obstructed access to a desirable toy. A desirable prize was locked inside a translucent, plastic box. Children were instructed to try to get the prize out, but were given keys that would not open the box. Each child was required to work on the box for two minutes without interaction with the experimenter. Child behaviors were coded over four 30-second epochs for intensity of frustration ranging from 0 (*no observed response*) to 2 (*obvious, strong response*). Coded behaviors included body motions (e.g., frustrated hand movements, slamming the keys), facial expressions (e.g., furrowed brow, pursed lips), vocalizations (e.g., sighs, grunts), and annoyance directed toward the experimenter (e.g., glancing at experimenter, questions/statements posed to experimenter). Appropriately asking the experimenter for help was not included in scores of frustration. An overall frustration score for each 30-second epoch was assigned based on the number of behaviors coded. Total scores were the average overall rated frustration across all four epochs. Internal consistency of the frustration scale was .72, and the inter-rater ICC was .79.

**2.3.3.3 Executive Control:** Executive control was assessed using six tasks measuring attention regulation and behavioral and cognitive inhibitory control, including the Inhibition and Auditory Attention subscales of the NEPSY, the Bear-Dragon task, the Day-Night task, the Dimensional Change Card Sort, and Head, Toes, Knees, Shoulders (each described in detail below). The Inhibition subtest assesses a child's ability to inhibit a dominant response in order to enact a novel response. Specifically, children are shown an array of circles and squares and asked to label each shape in an opposite manner (e.g., say circle when they see square) while being timed. The Auditory Attention subtest is a continuous performance test that assesses the ability to be vigilant and to maintain and shift selective auditory set. Children are required to listen to a series of words and respond only when they hear a specific target word, while refraining from response to all other words. Total scores were calculated as the proportion of correct responses to the total possible score, with a potential range of 0 to 1. Average scores at T1 were 0.09 (*SD* = 0.24, *Range* = 0.00-0.93) and 0.18 (*SD* = 0.32, *Range* = 0.00-1.00) for Auditory Attention and Inhibition respectively. Subscales of the NEPSY were designed for use with children 5 and older (Korkman, Kirk, & Kemp, 1998). However, the scales were administered to allow use of identical measures of effortful control over time. Thus, these tasks were understandably difficult for children in this sample.

Behavioral inhibitory control was assessed using the Bear-Dragon task, which requires the child to perform actions when a directive is given by a bear puppet, but not when given by a dragon puppet (Kochanska, Murray, Jacques, Koenig, & Vandegeest, 1996). Children's actions were scored as performing no movement, a wrong movement, a partial movement, or a complete movement, with scores ranging from 0-3. Total scores were the proportion of the score across both bear and dragon items to the total possible score (*M* = 0.62, *SD* = 0.20, *Range* = 0.33-1.00).

Cognitive inhibitory control was assessed using the Day-Night task, which requires the child to say “day” when shown a picture of moon and stars and “night” when shown a picture of the sun (Gerstadt, Hong, & Diamond, 1994). Children's actions were scored 1 for correctly providing the non-dominant response or 0 for providing the dominant response. Total scores were the proportion of correct responses (*M* = 0.44, *SD* = 0.33, *Range* = 0.00-1.00).

The Dimensional Change Card Sort (DCCS) assesses cognitive inhibitory control, attention focusing and set shifting (Zelazo, Muller, Frye, & Marcovitch, 2003). In this task, children were introduced to two black boxes with slots cut in the top. Target cards, consisting of a silhouetted figure on a colored background (star on blue background and truck on red background), were attached to the front of each box. Children were instructed to sort cards according to first the shape (6 trials) and then color (6 trials) properties on the target cards. The experimenter stated the sorting rule before each trial, and presented a card and labeled it according to the current dimension (e.g., on a shape trial, “Here's a truck. Where does it go?”). If children correctly sorted ≥50% of cards, they advanced to the next level in which the target cards integrated the sorting properties. Target cards consisted of a colored figure on a white background (blue star and red truck), and children were again instructed to sort according to shape (6 trials) and then color (6 trials). If they correctly sorted ≥50% of the cards, children advanced to the next level in which they were instructed to sort by one dimension (color) if the card had a border on it and by the other dimension (shape) if the card lacked the border (12 trials). The score was the proportion of correct trials out of the total possible of 36 trials (*M* = 0.42, *SD* = 0.20, *Range* = 0.00-0.89).

Head, Toes, Knees, Shoulders (HTKS) integrates attention and inhibitory control (Ponitz, McClelland, Jewkes, Connor, Farris & Morrison, 2008). Children are asked to follow the instructions of the experimenter, but to enact the opposite of what the experimenter directs (e.g., touch toes when asked to touch head). Behaviors were coded as 0 (*touched directed body part*), 1 (*self-corrected his/her behavior*), and 2 (*only touched opposite body part*). Total scores were the proportion of the score across items to the total possible score (*M* = 0.01, *SD* = 0.07, *Range* = 0.00-0.65). Twenty percent of all executive control tasks were independently re-scored. ICC's on all tasks ranged from .72-.98.

Consistent with previous research, an overall executive control score that integrated attention shifting and focusing (Auditory Attention, DCCS), behavioral inhibitory control (Bear-Dragon, HTKS), and cognitive inhibitory control (Inhibition, Day-Night) was computed as the mean of the proportion scores of the six tasks (Kochanska et al., 1996; Carlson & Moses, 2001; Lengua, Hornado, & Bush, 2007). Executive control scores were considered missing if > 50% of the component scores were missing. Internal consistency of the composite executive control measure was .67, and the inter-rater ICC was .83.

**2.3.3.4 Delay Ability:** Delay ability was assessed using a gift delay task (Kochanska et al., 1996). In this task, the child was told that s/he would receive a present, but that the experimenter wanted to wrap it. The child was instructed to sit facing the opposite direction and to not peek while the experimenter noisily wrapped the gift. Children's peeking behavior (frequency, degree, latency to peek, latency to turn around) and difficulty with the delay (e.g., fidgeting, tensing, facial grimaces) were rated. Latencies and behavior scores were converted to proportions of total possible times/scores and averaged. Internal consistency of the composite delay ability measure was .77, and the inter-rater reliability was .91.

**2.3.4 Child Adjustment—**At both time points, teachers rated children's adjustment problems using the preschool teacher form of the SSRS. Teachers rated children's externalizing problems (7 items), internalizing problems (6 items) and hyperactivity (6 items) for a total adjustment problems score (19 items). The SSRS was standardized on a large national sample. Validity of the teacher SSRS was established based on significant correlations with the Harter Teacher Rating Scale (TRS; Harter, 1985), the Social Behavior Assessment (SBA; Stephens, 1981), and the Child Behavior Checklist-Teacher report form (CBCL-TRF; Achenbach & Edelbrock, 1986). The adjustment problems scale of the SSRS showed positive correlations with problem behaviors as measured by the SBA and CBCL-TRF and negative correlations with self-perception on the TRS (Gresham & Elliot, 1990). In this study, alpha for the adjustment problems scale was .87.

### 2.4 Analytic Plan

Families were included if they had available data from at least one time point. Of the original 306 families, 47 families were missing data on one or more variables (fear: n = 16, frustration: n = 15, executive control: n = 0, delay ability: n = 38) used to calculate interaction terms, which, as exogenous variables in the models tested, could not be estimated using missing-variable analyses. Participants with missing data on any variable were compared to those with complete data on all T1 variables: demographics (child gender, family income, cumulative risk), negative reactivity (observed fear and frustration), effortful control (executive control and delay ability), and outcomes (total problems). The *t* tests indicated that participants with any missing data ($n = 185$) differed from those with no missing data ($n = 121$) on income (missing, $M = 8.34$, $SD = 3.79$; no missing, $M = 9.37$, $SD = 4.07$), $t(304) = -2.27$, $p = .02$; and executive control (missing, $M = 0.27$, $SD = 0.15$; no missing, $M = 0.31$, $SD = 0.15$), $t(304) = -2.86$, $p = .01$. However, the relations of income and executive control to missingness were small effects ($r = .13$ and $r = .16$, respectively) and did not reach previously cited thresholds for introducing substantial bias (e.g., $r > .40$; Collins, Schafer, & Kam, 2001). Analyses, therefore, were based on the sample of 259 families who had complete data to compute interaction terms.

Full Information Maximum Likelihood Estimation (FIMLE) was used to handle missing data, which has been found to be less biased and more efficient than other techniques for missing data (Arbuckle, 1996). Our examination of bias in missing data (above) suggested that the pattern of missing data introduced minimal bias and aligned with the assumptions of FIMLE. Mediation analysis, 2- and 3-way interactions were tested using hierarchical linear regressions, and profile analyses were conducted using LPA, both in Mplus Version 6.11 (Muthén & Muthén, 1998-2011).

## 3. Results

### 3.1 Variable Centered Approach

Descriptive statistics for all study variables are presented in Table 2. Both components of negative reactivity (fear, frustration), both components of effortful control (executive control, delay ability), cumulative risk, and the 2-way and 3-way multiplicatives of these variables were entered as simultaneous predictors of children's problems in a single hierarchical regression equation. Temperament interaction terms included one reactivity and one effortful control dimension (i.e., executive control × fear, executive control × frustration, delay ability × fear, delay ability × frustration), but interactions between reactivity components (fear × frustration) or effortful control components (executive control × delay) were not tested. Thus, total problems at T2 was regressed on five direct effects, eight 2-way interactions, and four 3-way interactions, tested simultaneously. Following the recommendation by Curran, Bauer, and Willoughby (2004), all components included in interaction terms were mean centered. The centered values were then used to create the multiplicative terms, as well as entered as direct predictors in the regression equations. Each equation also included child gender and family income as covariates, as well as total problems at T1 to control for initial levels of problems so that models were predicting relative changes in adjustment across 18 months. Mediation was also simultaneously tested by including cumulative risk as a predictor of each of the four dimensions of temperament. Indirect effects of cumulative risk through temperament were tested using bias-corrected bootstrapped confidence intervals in MPlus (Muthén & Muthén, 1998-2011). The results of the regression equation are summarized in Table 3 and indirect effects are visually presented in Figure 1.

#### 3.1.1 Direct Effects of Cumulative Risk, Temperament Reactivity, and Effortful Control—

In examining direct effects predicting relative changes in children's problems across 18 months, initial levels of problems positively predicted later problems ($b = 0.26$, $SE = 0.11$, $p = .02$) suggesting some continuity in adjustment over time. Lower family income ($b = -0.37$, $SE = 0.15$, $p = .01$), but not cumulative risk ($b = 0.50$, $SE = 0.94$, $p = .59$), prospectively predicted higher problems above the stability of problems over time. Additionally, child gender related to adjustment ($b = 2.79$, $SE = 0.91$, $p = .002$) such that boys demonstrated more total problems. A few direct effects of temperament characteristics emerged (see Table 3). However, these direct effects appear to be conditioned and should be interpreted in the context of conditional variables, as discussed in results of interaction effects.

#### 3.1.2 Two- and Three-way Interactions among Risk, Reactivity, and Effortful Control—

Contrary to expectation, none of the 3-way interaction effects were significant suggesting the interactive effects of reactivity and risk on children's problems were not conditioned by effortful control. However, multiple 2-way interactions emerged. Significant interactions were plotted and examined further by testing the simple intercepts and slopes at values ±1 *SD* from the mean of each predictor and moderator. Three 2-way interactions significantly predicted children's total problems at T2 above direct effects of child gender, initial problems, and family income: cumulative risk × fear, cumulative risk × frustration, and delay ability × frustration.

The interaction between fear and cumulative risk was significant ($b = -6.19$, $SE = 2.92$, $p = .03$; Figure 2a). Regardless of children's fear reactivity, cumulative risk was positively related to total problems with significant slopes for children low ($b = 4.55$, $t = 5.45$, $p < .01$), moderate ($b = 3.31$, $t = 5.47$, $p < .01$), and high in fear reactivity ($b = 2.07$, $t = 2.31$, $p = .02$), with the strongest association between cumulative risk and total problems for children with low fear reactivity.

Significant interactions also emerged between frustration and cumulative risk ($b = 17.22$, $SE = 6.05$, $p = .004$; Figure 2b), as well as frustration and delay ability ($b = 32.03$, $SE = 13.51$, $p = .02$; Figure 2c). For children with moderate to high frustration reactivity, cumulative risk was significantly, positively related to total problems ($b = 3.09$, $t = 4.79$, $p < .01$; $b = 4.22$, $t = 5.80$, $p < .01$, respectively). The relation between cumulative risk and adjustment problems was weaker and only marginally significant, however, for children low in frustration reactivity ($b = 1.95$, $t = 1.93$, $p = .06$). Children living in high risks context who also had lower frustration had lower total problems compared to children living in equally risky contexts but with average to high frustration.

The interaction between frustration and delay ability demonstrated that for children with high frustration, delay ability was unrelated to total problems ($b = -1.97$, $t = -0.79$, $p = .43$)

with high rates of problems regardless of ability to delay gratification. Children with low to moderate frustration, however, demonstrated fewer total problems at higher levels of delay ability ($b = -8.49$, $t = -3.15$, $p = .002$; $b = -5.27$, $t = -2.75$, $p = .01$, respectively).

**3.1.3 Indirect Effects of Risk on Problems—**The indirect effects of cumulative risk, through temperament, on relative change in children's total problems across 18 months were tested. Despite cumulative risk significantly predicting both executive control ($b = -.03$, $SE = 0.01$, $p = .001$) and delay ability ($b = -0.06$, $SE = 0.02$, $p = .001$), results generally did not support indirect effects of risk on problems through temperament. Cumulative risk was not a significant predictor of either fear or frustration reactivity. Only a trend for an indirect effect of risk on problems through delay ability emerged ($b = .23$, $SE = 0.02$, $p = .08$). Using bias-corrected bootstrap confidence intervals (CI), at 90%, the CI ranges 0.01, 0.53, however the 95% CI includes zero (−0.06, 0.59) suggesting the indirect effect of cumulative risk on problems through negative effects on delay ability is not reliable.

### 3.2 Person Centered Approach

Latent profile analysis was used to examine whether the patterning of reactivity and regulation, simultaneously accounting for fear, frustration, executive control and delay ability, would provide further clarification regarding the interactions among reactivity, effortful control and cumulative risk examined above. LPA analysis identified four latent classes of temperament profiles. Starting with a 1-class model, classes were added iteratively until either the addition of a class did not improve or detracted from the model. Information criterion statistics were used to determine class number including Bayesian information criterion (BIC; Schwarz, 1978), Adjusted Bayesian Information Criterion (Adjusted BIC; Sclove, 1987) and Akaike Information Criterion (AIC: Akaike, 1973). Entropy was also examined, with values approaching 1 suggesting superior class identification (Celeux & Soromenho, 1996). Finally, the Lo-Mendell-Rubin (LMR) test (Lo, Mendell, & Rubin, 2001) was also examined to determine the appropriate number of classes represented by the data. Table 4 shows BIC, Adjusted BIC, AIC, Entropy, and Lo-Mendell-Rubin test values for the models with increasing numbers of classes. As is often the case, the different statistics suggested different optimal solutions, with two of the four indicators pointing to a 4-class solution as the best fit to the data, and a trend toward a significant LMR test favoring the 4-class solution. The 4-class solution was selected as it appeared to differentiate between fear and frustration reactivity beyond a high negative reactivity class represented in the 3-class solution, which was of conceptual relevance here.

**3.2.1 Latent Profiles—**The results of the latent profile analyses are presented in Figure 3, which displays the deviation of the class mean from the overall sample for the four temperament variables. Profile 1 (16% of the sample) was characterized by lower than average fear and frustration and higher than average executive control and delay ability. We, therefore, refer to this profile as the “low negative reactivity, high effortful control” profile. Profile 2 (36% of the sample) was characterized by higher than average fear, average levels of frustration, and lower levels of executive control and delay ability. We refer to this profile as the “high fear” profile. Profile 3 (10% of the sample) was characterized by higher than average fear, frustration, executive control, and delay ability. We refer to this profile as “high negative reactivity, high effortful control". Profile 4 (38% of the sample) was characterized by low levels of fear, average levels of frustration and lower than average executive control and delay ability. We refer to this profile as "low fear, low effortful control."

**3.2.2 Profile relations with study variables—**For each profile, subjects are assigned probabilities representing the likelihood their characteristics fit the profiles, ranging from .00 to 1.0. Profile probabilities were then examined in relation to income, cumulative risk and adjustment (Table 5). Having a higher probability of belonging to Profile 1 (low negative reactivity, high effortful control) was associated with higher income, with a trend toward an association with lower adjustment problems. A higher probability of having Profile 2 (high fear) was not significantly associated with other study variables, but demonstrated a trend toward an association with lower income. A higher probability of belonging to Profile 3 (high negative reactivity, high effortful control) was associated with higher income, lower cumulative risk, and lower adjustment problems. A higher probability of having Profile 4 (low fear, low effortful control) was associated with higher cumulative risk and higher adjustment problems.

**3.2.3 Profiles as mediators of risk—**In regression analyses, child gender, income and cumulative risk were tested as predictors of profile probabilities, which in turn, were tested as predictors of adjustment problems. A higher probability of being in Profile 1 (low negative reactivity, high effortful control) was predicted by higher income, while a higher probability of being in Profile 3 (high negative reactivity, high effortful control) was predicted by being a girl. A higher probability of being in Profile 4 (low fear, low effortful control) was predicted both by being a boy and by higher cumulative risk. None of the profiles predicted adjustment problems above the effects of the prior levels of problems, income and cumulative risk. Therefore, there was no support for the hypothesis that the profiles mediate the effects of cumulative risk on adjustment problems. These results largely mirror the mediation results found using variable centered approaches, suggesting that profiles do not appear to mediate the effects of contextual risk on adjustment.

**3.2.4 Profiles as moderators of risk—**To test whether certain profiles contributed to children's vulnerable or resilient responses to risk, regression analyses were conducted to test the interactions of cumulative risk with profile probabilities. First, child gender, income and cumulative risk were entered in a regression model, followed by the profile probabilities, and then the multiplicative term of cumulative risk with each of the profile probability values. All variables were mean-centered in calculating interaction terms. The profile variables assign to each person a probability of being in each of the four profiles, as such they are not entirely independent. Once accounting for the probability of belonging in three of the profiles, the probability of being in the fourth is fully defined. Therefore, only three profiles can be included simultaneously in the regression as adding the final profile would be completely redundant with the information provided by the other three profiles. Because Profile 2 probabilities were not related to adjustment problems, this profile was not examined in the regression analyses. However, to ensure that important information was not lost by excluding Profile 2, the identical analyses were conducted excluding Profile 1 instead, and the results were essentially identical, with no evidence of Profile 2 mediating or moderating risk.

Regression results are presented in Table 6. The first three columns present beta coefficients of the probabilities of profile membership regressed on study covariates. Columns under the heading “Adjustment Problems” present unstandardized and standardized beta coefficients, standard errors and confidence intervals for children's teacher-reported adjustment problems regressed on the same covariates (Step 1), as well as profile membership probabilities (Step 2), and interactions between cumulative risk and profile membership probabilities (Step 3). Being a boy, having lower income and higher cumulative risk significantly predict adjustment problems after controlling for T1 levels of problems, suggesting they predicted relative increases in problems over time. Above the effects of gender, income and cumulative risk, a higher probability of being in Profile 4 predicted higher adjustment problems. There were no significant direct effects of probabilities of Profile 1 or 3 on adjustment problems. There were also no significant indirect effects of cumulative risk on adjustment problems through the profile probabilities.

In addition to direct effects, there was one significant interaction and a trend toward a significant interaction between cumulative risk and the profiles. The probability of being in Profile 4 (low fear, low effortful control) interacted significantly with cumulative risk to predict adjustment problems such that cumulative risk was more strongly and significantly related to higher problems for children with a higher ($b$ = 4.38, SE = 1.12, $t$ = 3.19, $p$ = .000) and average probability ($b$ = 2.06, SE = 0.86, $t$ = 2.41, $p$ = .017) of demonstrating Profile 4, but unrelated for children unlikely to be in Profile 4 ($b$ = −0.25, SE = 1.17, $t$ = −0.21, p = .834; see Figure 4a). There was a trend toward an interaction between cumulative risk and the probability of being in Profile 3 (high negative reactivity, high effortful control). Cumulative risk was unrelated to adjustment problems for children with a low probability of being in Profile 3 ($b$ = 0.00, SE = 0.83, $t$ = 0.00, p = .999), whereas it was significantly related to higher problems for children with a mean ($b$ = 2.06, SE = 0.86, $t$ = 2.41, $p$ = .017) and higher probability of demonstrating Profile 3 ($b$ = 4.13, SE = 1.18, $t$ = 3.50, $p$ = .001). It is interesting to note that when cumulative risk was low, children with a high probability of being in Profile 3 demonstrated lower adjustment problems, consistent with a differential susceptibility model (Figure 4b).

## 4. Discussion

By using both variable-centered and person-centered approaches, this study captures the dynamic interactions or processes of reactive and regulatory characteristics of temperament and how dimensions of temperament might simultaneously contribute to vulnerable or resilient responses to risk. Comparing across results drawn from both profile- and variable-centered tests of mediation and moderation, there was very limited evidence of temperament serving as a mediator of the relation between cumulative risk and children's adjustment problems , whereas there was some support for temperament moderating, exacerbating or mitigating, the effects of cumulative risk on adjustment.

With regard to mediation, only delay ability appeared to account for some of the effect of cumulative risk on adjustment problems. These results support prior research that has found evidence for a potential adverse impact of poverty in early childhood on self-regulatory behavior (Evans & English, 2002; Evans, Gonnella, Marcynyszyn, Gentile, & Salpekar, 2005), and, specifically, that deficits in delay of gratification mediate the effect of poverty on children's poorer academic achievement (Evans & Rosenbaum, 2008). It may be that children growing up in high-risk contexts are actually reinforced for pursuing immediate rewards given the uncertain and unpredictable nature of their environments, resulting in less opportunity to develop strategies for delaying gratification and resulting in blunted regulation ability. Although pursuing immediate gratification in their general context may be, to some degree, beneficial, in a classroom setting these behaviors may become maladaptive leading to higher ratings of problem behaviors perceived by teachers as children enter preschool. It's important to highlight that the indirect effect through delay ability was only significant at a trend level and, as such, should be interpreted with caution. Additionally, mediation was not supported from the person-centered approach.

Both approaches did, however, provide useful and complementary evidence supporting the moderating effect of temperament in the relation between risk and problems. In the variable approach, low fear and high frustration, particularly frustration in the presence of low delay, were shown to exacerbate the effects of cumulative risk. These findings parallel the results from the person-centered approach that a higher probability of being in Profile 4, low fear and low effortful control, amplified the adverse effects of cumulative risk. Interestingly, high fear appears to be somewhat protective in high-risk contexts such that highly fearful children have fewer total problems than fearless children in these high-risk environments. Although cumulative risk still confers vulnerability to problems regardless of fear reactivity, high fear appears to mitigate this relation to some degree. Prior research has also found evidence of higher fear reactivity serving as a protective factor, particularly for the development of externalizing disorders and antisocial behavior (Keiley, Lofthouse, Bates, Dodge, & Pettit, 2003). It is possible that highly fearful children, who are more prone to inhibit or withdraw in novel or threatening contexts, have less exposure to negative influences or dangerous experiences in their environment and, to a small degree, are protected from the negative consequences of high-risk contexts (Rothbart & Bates, 1998). Children with lower than average fear reactivity, alternatively, may more quickly approach unfamiliar situations, engage with the environment more readily, and may more frequently come into contact with negative aspects of their environment leading to poorer adjustment (Shaw, Gilliom, Ingoldsby, & Nagin, 2003).

Similar to interactions between cumulative risk and fear reactivity, the variable centered analyses indicated that in low-risk contexts, children low and high in frustration were indistinguishable in their levels of adjustment problems. In low-risk contexts, children sensitive to limitations, failure, or blocked goals may be exposed to fewer distressing stimuli, or alternatively, observable expressions of frustration may be better tolerated or managed by the environment resulting in smaller impacts on teacher's perceptions of children's problem behaviors. In high-risk contexts, however, where limitations and blocked goals may occur more regularly, highly frustrated children appear particularly vulnerable to problem behaviors, a finding consistent with previous evidence (cf., Lengua & Wachs, 2012).

In addition, the interaction between frustration and delay ability also significantly predicted relative changes in children's problem behaviors. Specifically, delay ability appears to be a protective factor only in the context of low to average frustration. High frustration reactivity may overwhelm children's ability to delay gratification even for children with a relatively strong capability. When a child is not easily frustrated, the ability to put off rewards in service of larger goals or socially appropriate behavior relates to fewer problems (Krueger, Caspi, Moffitt, & White, 1996; Mischel & Ayduk, 2011). However, when children are high in frustration reactivity, the protective effects of delay may be overshadowed such that even children very capable of putting off reward are still vulnerable to higher rates of problems. Interactions between frustration and delay ability are particularly interesting within the broader pattern of associations between cumulative risk, frustration, and delay ability found in this study. Overall these results suggest that children with high frustration are not only more vulnerable to the adverse effects of cumulative risk, with particularly poor adjustment in combination with low delay ability, but that living in high-risk contexts may also result in deficient delay ability. Thus, children prone to frustration may be especially susceptible to consequences of high-risk contexts as vulnerability is conferred through multiple pathways.

The pattern of associations for both frustration and fear emerging from the variable-centered analyses were consistent with a diathesis-stress model, which suggests that certain characteristics amplify or increase the likelihood of maladjustment in response to stress or risk (Wachs, 1992). Interestingly, frustration and fear showed contrasting relations to vulnerability with high frustration reactivity, but low fear reactivity acting as a diathesis, exacerbating the effects of risk. In these interactions, neither fear nor frustration demonstrated a pattern of effects consistent with a differential susceptibility model, which would have predicted that, due to higher plasticity to either negative or positive contexts, highly reactive children would demonstrate lower adjustment problems in the context of low risk (Ellis & Boyce, 2008). Rather, in the variable-centered analyses there were no differences in level of adjustment problems at the low end of contextual risk, suggesting that a diathesis-stress model better accounts for these associations.

In contrast, results from the person-centered approach demonstrated some support for differential susceptibility. Where the variable interaction tests pointed to fear and frustration as unique moderators of the effects of risk, the profile analyses clarified the role of concurrent dimensions of temperament and relations between risk and adjustment. Specifically, and consistent with differential susceptibility models, high fear coupled with high frustration and high effortful control predicted greater problems in high-risk contexts, but predicted lower problems in a low-risk contexts. Comparison of variable- and person-centered approaches suggests that the frequent mixed support found in the literature for differential susceptibility as opposed to vulnerability or diathesis stress models (Lengua & Wachs, 2012; van IJzendoorn & Bakermans-Kranenburg, 2012) might be accounted for by the need to capture the effects of multiple reactivity and self-regulation characteristics simultaneously. However, the implication of this interaction should be interpreted cautiously as it was a trend toward an association and not statistically significant.

It was surprising that effortful control did not moderate the effects of cumulative risk as it has in past studies (e.g., Lengua et al., 2008; Veenstra, Oldehinkel, De Winter, Lindenberg, & Ormel, 2006). However, much of the prior research examining these relations has been conducted on older children. Unique to this study was the examination of these relations in a preschool-age sample of children, which is a period during which effortful control is developing rapidly and developmental trajectories of regulation are being shaped by contextual experiences (Rothbart, Ahadi, & Evans, 2000). Perhaps because effortful control is emerging and developing rapidly in the preschool period, it plays less of a protective role at this stage than it does at later points of development. The person-centered tests of interactions between cumulative risk and the probability of profile membership potentially hints at the prospective effects of effortful control in relation to vulnerability and resilience in the face of contextual risk. For example, a higher probability of being in Profile 4, which reflected low fear and low effortful control (both executive control and delay ability below average), exacerbated the effects of cumulative risk on adjustment problems. In contrast, a low probability of being in Profile 4 appeared to have a buffering effect, being associated with lower levels of problems. This mitigation of the effects of cumulative risk on adjustment might point to the early protective effects of higher effortful control.

### 4.1 Strengths and Limitations

It is important to highlight that mediation and moderation effects found in this study predicted adjustment above the stability of problems over time (i.e., controlling for total problems at T1). The use of longitudinal data and a developmental framework supports conclusions about direction of effects, and is a particular strength of the study. However, it is possible that the time frame of the analyses (i.e., 18 mos.) was too short to capture developmental changes in children's adjustment given the moderate to high stability of the adjustment measures. In addition to predicting problems above stability, this study also examined the impact of cumulative risk above the direct effect of family income. Thus, these findings specifically point to the impact of the additive burden of contextual risk, which predicted unique variance in children's adjustment over direct financial resources. As the sample was recruited to represent a full range of income levels, this study is particularly equipped to provide a rigorous test of the effects of income and income-related risk in relation to children's temperament and adjustment.

Another strength is the use of objective measures of temperament, as maternal-reports on questionnaire measures may have been biased by the very nature of this study and the variables of interest, specifically stress associated with low income and cumulative risk. While objective measures of temperament might capture individual differences more accurately, they might also fail to capture patterns of children's behavior across situations and time. Additionally, although coders of the objective measures were extensively trained and inter-rater reliability estimates were high, the majority of the objective measures were only coded once, which may introduce bias in the ratings (Furr & Funder, 2007). As such, alternative measurement methods may have resulted in quite different results and future research should examine the impact of measurement method on these relations. Additionally, our findings may be limited by the use of teacher-reported outcomes, which may only capture children's behavior within a classroom context. However, the use of teacher reports reduces the potential effects of reporter bias or method effects compared to mothers reporting on both cumulative risk and child adjustment. Finally, power to detect interaction effects is often quite low as effect sizes in social sciences are frequently, small and complex models including moderation and mediation, such as the one tested, are at further disadvantage due to the inclusion of multiple interaction terms and indirect effects (Fairchild & MacKinnon, 2009). It is possible that there was insufficient power to detect significant interaction, and particularly 3-way interaction, effects, despite a relatively large sample.

### 4.2 Future Directions

The findings of this study primarily give support to the moderating as opposed to mediating role of temperament in the relation between cumulative risk and children's adjustment outcomes during early childhood. In particular, these findings point to the need for continued research examining more complex models accounting for multiple domains of temperament, which may require testing three-way interactions, mediated-moderation models, and person-centered approaches. Multiple approaches help to explain not only under what conditions temperamental vulnerabilities influence adjustment (i.e., through moderation), but also how this risk or resiliency is conferred (i.e., through mediation). In addition, continued efforts to conduct longitudinal studies will allow for examining complex models of the effects of temperament across development. In particular, exploring person-centered approaches to temperament across multiple time points presents a promising direction for future research. Designs such as these may highlight stability and organization of the configuration of temperament characteristics, increases or decreases in the prevalence of certain profiles as children mature, and how maintenance or change in profile characteristics may both be influenced by contextual risk factors and relate to children's resilient or poor adjustment to contextual risk.

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## Highlights

- Temperament appears to moderate, as opposed to mediate, effects of risk on adjustment outcomes in preschool-age children.

- A person-centered approach points to the potential simultaneous impact of multiple temperament dimensions.

- High frustration, low fear and low delay ability contribute to vulnerability to risk exposure.

- Evidence supports diathesis-stress and vulnerability models.

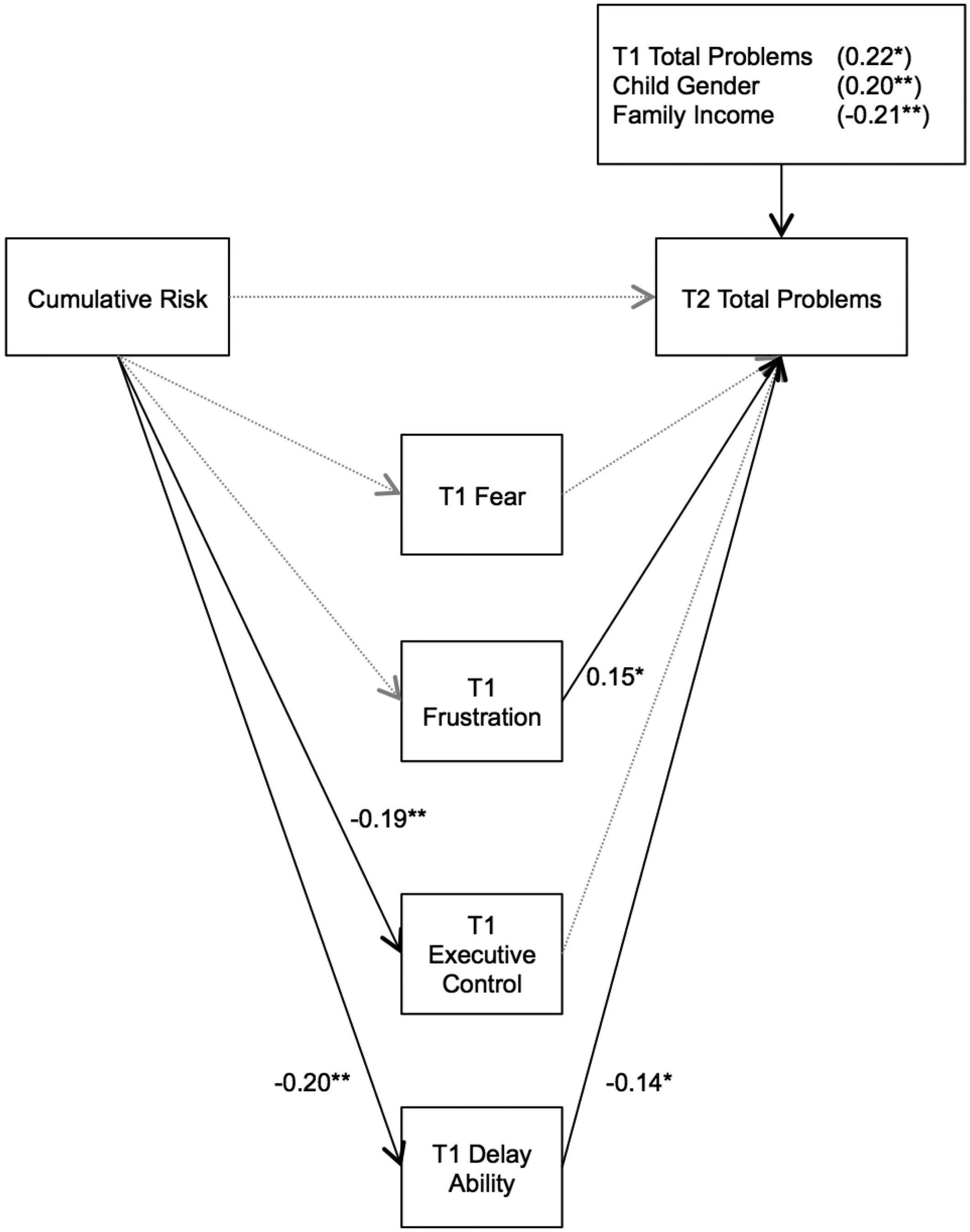
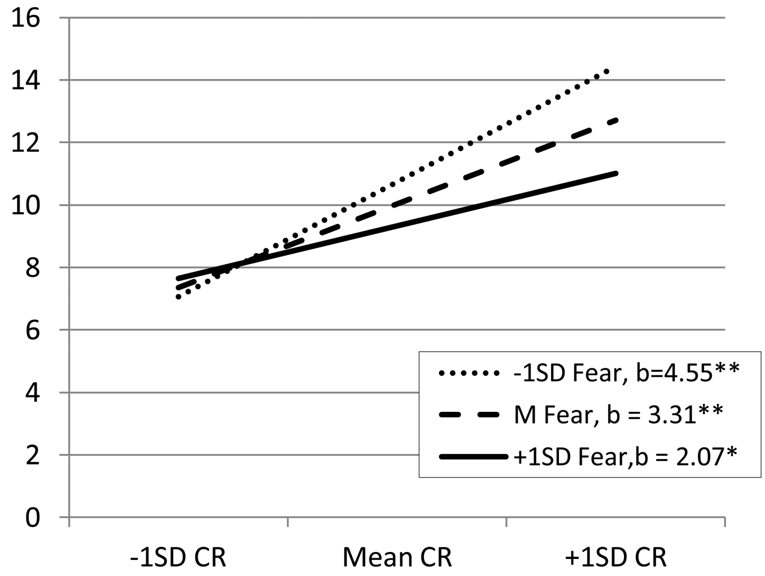
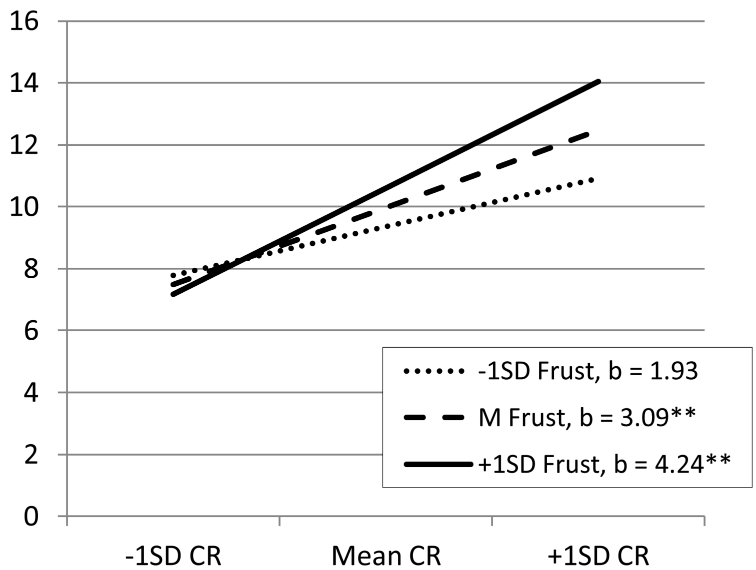



**Figure 1.**

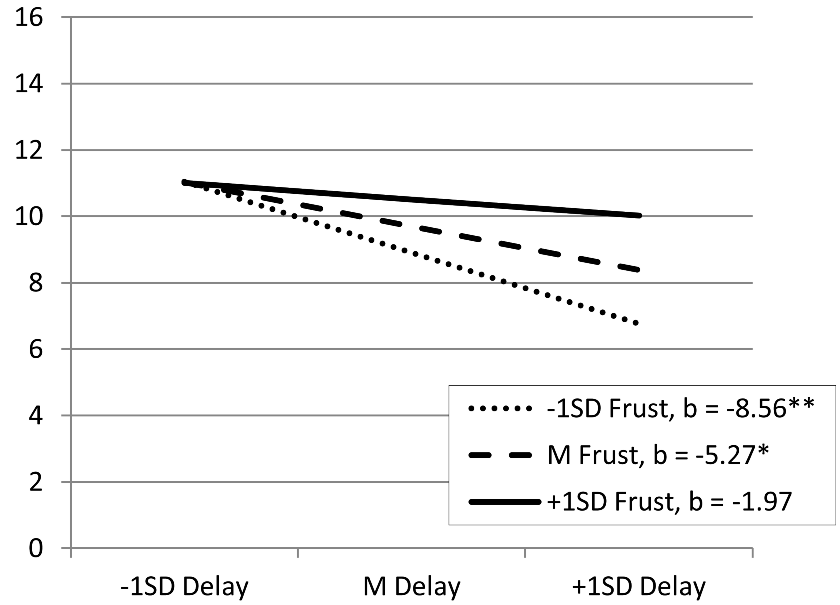
Mediation analyses. Standardized beta coefficients from regressions testing the effects of cumulative risk on temperament, temperament's effect on relative change in problems, and indirect effects of cumulative risk through temperament. Non-significant paths are designated by grey lines. Indirect effect of cumulative risk through delay ability was trend only ($b = 0.23$, $SE = 0.02$, $p = .08$, 95% CI = −0.06, 0.59). Note: * $p < .05$, ** $p < .01$.




(a) Cumulative Risk x Fear




(b) Cumulative Risk x Frustration




(c) Delay Ability x Frustration

**Figure 2a-c.**

Moderation by temperament predicting adjustment problems. Using a variable-centered approach, (a) fear and (b) frustration moderated the relation between cumulative risk (CR) and relative change in children's problem behaviors. Frustration and delay ability (c) also interacted in predicting problems. Simple slopes were plotted at the mean and ±1 *SD* of predictors and moderators. Note: CR = cumulative risk, Frust = frustration, * $p < .05$, ** $p < .01$.

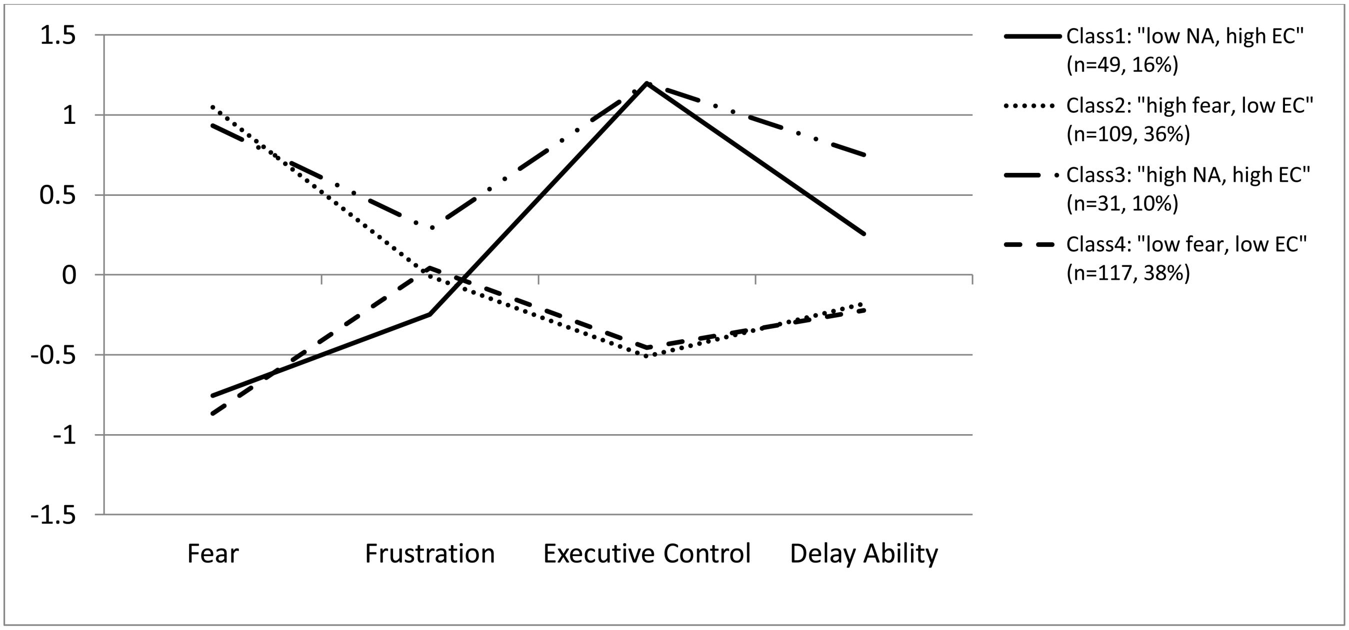
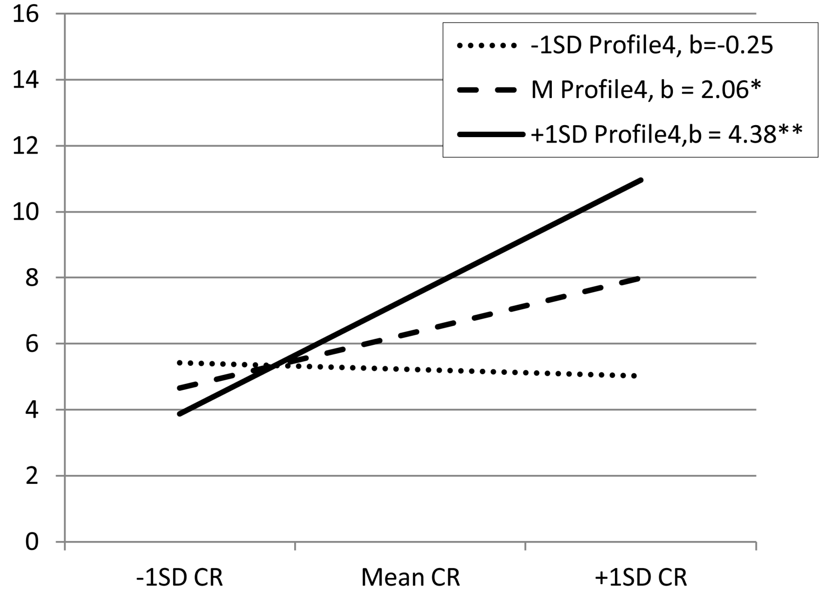
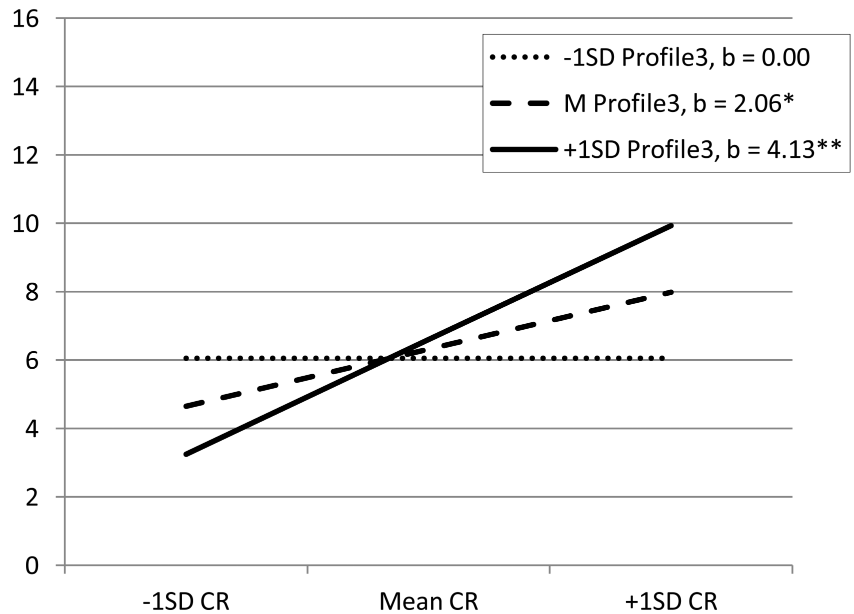



**Figure 3.**
Standard deviations from the overall sample mean of each class for observed fear, frustration, executive control and delay for the four-class latent profile solution. Note: NA = negative affect, EC = effortful control.




(a.) Cumulative risk x Profile 4 (low fear, low effortful control).




(b.) Cumulative risk x Profile 3 (high negative reactivity, high effortful control).

**Figure 4a-b.**

Interaction between cumulative risk and profile probabilities predicting adjustment problems. The probability of being in (a) Profile 4 and (b) Profile 3 moderated the relation between cumulative risk (CR) and relative change in children's problem behaviors. Simple slopes were plotted at the mean and ±1 *SD* of predictors and moderators. Note: CR = cumulative risk, * $p < .05$, ** $p < .01$.

### Table 1

Correlations among indices of risk included in Cumulative Risk score.

| | 1. ME | 2. SP | 3. AP | 4. RI | 5. HD | 6. NLE | 7. PD | 8. MD | Total Score |
|---|---|---|---|---|---|---|---|---|---|
| **1. Maternal Education** | -- | .08 | .09 | .08 | −.05 | .01 | .09 | .13* | .31** |
| **2. Single Parent** | | -- | .29** | .17** | −.04 | .06 | .31** | .22** | .72** |
| **3. Adolescent Parent** | | | -- | .30** | −.04 | .01 | .08 | .08 | .51** |
| **4. Residential Instability** | | | | -- | −.09 | .06 | .07 | .07 | .55** |
| **5. Household Density** | | | | | -- | −.13* | .01 | −.12* | .21** |
| **6. Negative Life Events** | | | | | | -- | .02 | .50** | .28** |
| **7. Parental Divorce** | | | | | | | -- | .02 | .43** |
| **8. Maternal Depression** | | | | | | | | -- | .40** |

Note:

* $p < .05$

** $p < .01$.

### Table 2

Descriptive statistics for study variables.

| Variable | | M | SD | Range | Skewness |
|---|---|---|---|---|---|
| Time 1 | | | | | |
| | Income | 8.75 | 3.93 | 0.50 - 14.00 | −0.78 |
| | Cumulative Risk | 0.90 | 0.81 | 0.00 - 4.50 | 1.83 |
| | Fear | 0.36 | 0.29 | 0.00 - 0.93 | 0.27 |
| | Frustration | 0.27 | 0.16 | 0.00 - 0.83 | 0.58 |
| | Executive Control | 0.29 | 0.15 | 0.00 - 0.77 | 0.66 |
| | Delay Ability | 0.62 | 0.25 | 0.09 - 1.00 | −0.01 |
| | Total Problems | 11.77 | 6.29 | 0.00 - 30.00 | 0.53 |
| Time 2 | | | | | |
| | Total Problems | 10.10 | 7.02 | 0.00 - 37.00 | 1.03 |

## Table 3

Regression coefficients for direct effects, 2-way, and 3-way interactions.

| Variable | | T2 Total Problems b | SE | β | 95% CI |
|---|---|---|---|---|---|
| Direct Effects | Gender | **2.79**** | 0.91 | 0.20 | 1.00, 4.58 |
| | T1 Problems | **0.26*** | 0.11 | 0.22 | 0.05, 0.48 |
| | Income | **−0.37*** | 0.15 | −0.21 | −0.65, −0.08 |
| | Risk | 0.50 | 0.94 | 0.06 | −1.34, 2.34 |
| | Fear | −1.69 | 1.77 | −0.07 | −5.15, 1.77 |
| | Frust | *6.50*† | 3.46 | 0.15 | −0.28, 13.29 |
| | EC | −0.27 | 4.07 | −0.01 | −8.25, 7.71 |
| | Delay | **−3.72*** | 1.84 | −0.14 | −7.32, −0.11 |
| 2-way Interactions | Fear × Risk | **−6.19*** | 2.92 | −0.20 | −11.92, −0.47 |
| | Fear × EC | −5.20 | 15.14 | −0.03 | −34.87, 24.46 |
| | Fear × Delay | 0.70 | 6.13 | 0.01 | −11.31, 12.71 |
| | Frust × Risk | **17.22**** | 6.05 | 0.33 | 5.35, 29.08 |
| | Frust × EC | −17.68 | 32.15 | −0.06 | −80.69, 45.33 |
| | Frust × Delay | **32.02*** | 13.51 | 0.19 | 5.54, 58.49 |
| | EC × Risk | −3.44 | 6.88 | −0.05 | −16.92, 10.03 |
| | Delay × Risk | 2.91 | 3.02 | 0.09 | −3.00, 8.82 |
| 3-way Interactions | Fear × EC × Risk | −24.18 | 26.37 | −0.11 | −75.86, 27.50 |
| | Fear × Delay × Risk | 0.81 | 9.88 | 0.01 | −18.57, 20.18 |
| | Frust × EC × Risk | −5.88 | 55.09 | −0.02 | −113.86, 102.10 |
| | Frust × Delay × Risk | 29.26 | 25.04 | 0.17 | −19.82, 78.34 |

Note: Frust = Frustration; EC = Executive Control

† $p = .06$

* $p < .05$

** $p < .01$.

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## Table 4

Summary of BIC, AIC and entropy measures for latent profile analysis of temperament fear, frustration, executive control and delay ability.

| # of Classes | BIC | Adjusted BIC | AIC | Entropy | Lo-Mendell-Rubin LRT |
|---|---|---|---|---|---|
| 1 | 3320.72 | 3295.35 | 3290.93 | -- | -- |
| 2 | 3189.17 | 3135.25 | 3125.87 | **0.896** | 166.77, p = .000 |
| 3 | **3168.90** | 3099.13 | 3086.98 | 0.784 | **18.81, p = .049** |
| 4 | 3174.19 | **3088.56** | **3073.65** | 0.831 | 27.00, p = .102 |

Note: BIC = Bayesian information criterion; AIC = Akaike information criterion; LRT = Likelihood Ratio Test.

## Table 5

Correlations among study variables, including profile probabilities.

| | PRB1 | INC | CR | FEA | FRU | EC | DA | P1 | P2 | P3 | P4 | PRB2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Child gender** | .02 | −.05 | −.01 | −.11 | .11 | −.09 | −.15* | −.02 | −.05 | −.12* | .14* | .25* |
| **T1 Problems (PRB1)** | −- | −27* | .23* | −.09 | .27* | −.32* | −.29* | −.11 | .14 | −.28* | .15* | .36* |
| **Income (INC)** | | −- | −.59* | −.03 | −.09 | .19* | .24* | .14* | −.11 | .14* | −.08 | −.35* |
| **Cumulative Risk (CR)** | | | −- | −.08 | .07 | −.16* | −.20* | −.08 | .00 | −.13* | .14* | .38* |
| **Fear (FEA)** | | | | −- | .06 | −.01 | .05 | −.40* | .80* | .42* | −.71* | −.10 |
| **Frustration (FRU)** | | | | | −- | −02 | −.14* | −.13* | −.01 | .13* | .03 | .12 |
| **Executive Control (EC)** | | | | | | −- | .26* | .61* | −.41* | .53* | −.38* | −.10 |
| **Delay Ability (DA)** | | | | | | | −- | .14* | −.14* | .34* | −.18* | −.21* |
| **Profile 1 (P1)** | | | | | | | | −- | −.40* | −.16* | −.27* | −.12 |
| **Profile 2 (P2)** | | | | | | | | | −- | −.11 | −.61* | −.09 |
| **Profile 3 (P3)** | | | | | | | | | | −- | −.36* | −.14* |
| **Profile 4 (P4)** | | | | | | | | | | | −- | .26* |
| **T2 Problems (PRB2)** | | | | | | | | | | | | −- |

Note:

** $p < .01$.

* $p < .05$

## Table 6

Regression coefficients for the effects of income, cumulative risk, profile membership probabilities and interaction terms on adjustment problems.

| | Temperament Profiles | | | Adjustment Problems | | | |
|---|---|---|---|---|---|---|---|
| | **β Pr 1** | **β Pr 3** | **β Pr 4** | **b** | **SE** | **β** | **95% CI** |
| **Step 1** | | | | | | | |
| Child Gender | −.01 | −.12* | .14* | **3.06**** | 0.88 | .22 | 0.10-0.34 |
| Income | .14* | .09 | .01 | −0.28t | 0.15 | −.15 | −0.31-0.01 |
| Cumulative Risk | .00 | −.08 | .15* | **1.97*** | 0.86 | .22 | 0.04-0.41 |
| T1 Total Problems | −- | −- | −- | **0.27**** | 0.10 | .24 | 0.07-0.42 |
| **Step 2** | | | | | | | |
| Profile 1 | | | | 0.82 | 1.69 | .04 | −0.12-0.19 |
| Profile 3 | | | | 1.50 | 2.14 | .06 | −0.10-0.21 |
| Profile 4 | | | | **2.57*** | 1.11 | .16 | 0.03-0.30 |
| **Step 3:** Cumulative Risk x | | | | | | | |
| Profile 1 | | | | 3.21 | 3.97 | .12 | −0.17-0.42 |
| Profile 3 | | | | 7.76t | 4.26 | .18 | −0.01-0.37 |
| Profile 4 | | | | **5.17**** | 1.70 | .27 | 0.10-0.45 |

Note: Pr = Profile

* $p < .05$

** $p < .01$.