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LONGITUDINAL ASSOCIATIONS BETWEEN TEMPERAMENT AND SOCIOEMOTIONAL OUTCOMES IN YOUNG CHILDREN: THE MODERATING ROLE OF RSA REACTIVITY

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ABSTRACT

Temperament is an important predictor of socioemotional adjustment, such as externalizing and internalizing disorders (Kagan & Fox, 2006; Rothbart & Bates, 2006; Pérez-Edgar & Fox, 2005). However, there is not a one-to-one correspondence between temperamental predispositions and these outcomes, implying that other factors also contribute to the development of internalizing and externalizing problems. Self-regulation is believed to interact with temperament, and hence, has also been studied as an important predictor for later socio-emotional outcomes (Rothbart, 2011). Respiratory sinus arrhythmia (RSA) is a psychophysiological measure of self-regulation (Beauchaine, 2001; Porges, 2007) that has been found to moderate the relation between other types of risk (e.g., parental drinking, marital conflict, domestic violence) and socioemotional disorders (El-Sheikh, 2001; El-Sheikh et al., 2001; Katz, 2007). The primary aim of the present study was to test RSA reactivity as a moderator of the relation between temperament in infancy and externalizing and internalizing problems at kindergarten entry. Results showed that RSA moderated the relation between exuberant and fearful temperament and externalizing behaviors. However, these results were different for boys and girls. The fearful temperament predicted later internalizing problems, but no moderation was present in predicting internalizing problems. These results are discussed in light of recent evidence regarding gender differences in the role of RSA as a protective factor for risk. Finally, this study explores RSA trajectories as moderators of the relations between early temperament and socioemotional problems.

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Introduction

Temperamental characteristics have been identified as important predictors for the development of socioemotional problems (e.g., internalizing and externalizing; Kagan & Fox, 2006; Rothbart & Bates, 2006; Pérez-Edgar & Fox, 2005). Several studies have shown a link between temperament dimensions (e.g., exuberance and fearful) and internalizing and externalizing symptoms (Kagan & Fox, 2006; Rothbart & Bates, 2006; Pérez-Edgar & Fox, 2005). However, there is not a one-to-one correspondence between temperamental predispositions and these outcomes, implying that other factors also contribute to the development of internalizing and externalizing problems. Empirical evidence suggests other factors such as self-regulation moderate the relations between temperament and its socioemotional outcomes (Eisenberg, Smith, & Spinard, 2011; Rothbart, 2011; Rothbart & Bates 2006). Respiratory sinus arrhythmia (RSA), in particular has been used as an important psychophysiological index of self-regulation that may forecast subsequent socioemotional outcomes (Porges, 2007; Beauchaine, 2001). The present study used this measure to examine if physiological self-regulation moderates the relationship between temperament at 18 months and kindergarten behavioral problems.

Temperament and Later Behavioral Outcomes

The study of temperament has been approached from different perspectives, yielding several definitions (Goldsmith et al., 1987; Shiner et al., 2012, and Marvielde &

De Pauw, 2013 for a review and comparison of some of the common approaches; see Rothbart, 2011, and Strelau, 1998 for a historical review). Regardless of distinct definitions, most researchers agree that temperament reflects biologically based individual differences that emerge in early life, which predispose the individual to certain feelings, thoughts, and behaviors (Kagan & Fox, 2006; Goldsmith et al., 1987; Rothbart & Bates, 2006).

After the revolutionary work of Kagan, Fox, and colleagues, two main temperamental types have emerged: high fear and exuberance. The fearful temperament is characterized by displays of fear and inhibition towards novelty. Children characterized as fearful show high reactivity towards changes in the environment and high levels of social withdrawal, particularly to unfamiliar persons (Garcia-Coll, Kagan, & Reznick, 1984; Kagan, Reznick, & Snidman, 1987). This temperament dimension has been mostly studied as behavioral inhibition (BI; e.g., Fox, Henderson, Marshall, Nichols, & Ghera, 2005), but also as shyness (Rapee & Coplan, 2010), social withdrawal, and anxious solitude (Gazelle & Rubin, 2010). However, it is often difficult to theoretically and empirically distinguish among these constructs. In addition, they are usually characterized through observation. For simplicity, and because the current study did not use laboratory observations to characterize temperament, this study uses the broader construct of fearful temperament. Nevertheless, when reviewing the literature, temperament will be discussed in the manner that the authors of the particular studies characterized temperament (i.e., fearful temperament and BI will be used interchangeably).

Across many studies, BI has been found to be moderately-highly stable from early childhood to adolescence (Goldsmith & Lemery, 2000) and even early adulthood (Caspi & Silva, 1995; Caspi et al., 2003; Degnan et al., 2008). In addition, children characterized as extremely behaviorally inhibited in infancy or childhood tend to show later internalizing disorders, especially anxiety (Caspi et al., 2003; Chronis-Tuscano et al., 2009; Hirshfeld, et al., 1992; Schwartz, Snidman, & Kagan, 1999; Stifter, Putnam & Jahromi, 2008; Pérez-Edgar & Fox, 2005 for a review). For example, Schwartz and colleagues (1999) reported that 61% of the children characterized as highly inhibited at age two showed symptoms of social anxiety at age 13, compared with 27% for non-inhibited children. Similarly, Buss (2011) found that children who were characterized as fearful across both high- and low-fear laboratory conditions (displaying dysregulated fear) at age two had higher maternal and teacher reported internalizing symptoms at the beginning of kindergarten. Findings of this nature demonstrate that fearful temperament is an important predictor of later internalizing problems.

The second temperamental type, exuberance, is characterized by high approach, activity level, impulsivity, displays of positive affect, and sociable behavior (Fox, Henderson, Rubin, Calkins, & Schmidt, 2001; Putnam & Stifter, 2005; Pfeifer, Goldsmith, Davidson & Rickman, 2002; Degnan et al., 2011). This dimension has also been referred to as uninhibition (Pfeifer et al., 2002) or surgency (Rothbart, 2011). As a temperamental construct, exuberance has shown stability from infancy to childhood (Degnan et al., 2011; Fox et al., 2001). Outcomes for exuberant children have been mixed, as some studies link exuberant temperament to externalizing behaviors (Putnam & Stifter, 2005; Stifter et al., 2008), while others relate it to sociability in childhood (Caspi

et al., 1995; Caspi et al., 2003; Fox et al., 2001). In the studies that focus on the relation between exuberant temperament and psychopathology, high approach and low self-regulation predict externalizing problems, which may be particularly salient in academic settings (Martel et al., 2007). For instance, using cluster analysis on 126 infants, Putnam and Stifter (2005) identified an exuberant cluster characterized by high positivity and behavioral approach. This exuberant group of children was particularly at risk for externalizing behaviors such as aggressive and destructive problems. Hence, exuberant temperament, just as fearful temperament, has been related to later behavioral problems.

Although the bulk of the work, as discussed above, demonstrates a link between fearful temperament and internalizing problems and the exuberant temperament and externalizing problems, there is some empirical and theoretical evidence that early extreme temperament is a risk for a broader set of maladaptive outcomes. For example, exuberant children are characterized, at the extreme, by high approach and unregulated behavior (Eisenberg et al., 2009); this may cause conflict with other peers, potentially leading to social rejection. As an illustration, Stifter et al. (2008) found that a group of exuberant toddlers were more likely to show both externalizing and internalizing behaviors at 4.5 years than a group of children characterized as only inhibited. On the other hand, children characterized as fearful due to social withdrawal are likely to experience peer rejection, victimization as well as lower academic and overall school adjustment (Rubin, Coplan, & Bowker, 2009). In addition, children characterized as behaviorally inhibited in childhood show less active social life in adulthood and a delay in adult competencies (e.g., moving away from family of origin; Gest, 1997). Consequently, exuberance and fear might also be associated with a broader set of

outcomes. Thus, it is important to explore these non-specific associations between temperament and a broader set of maladaptive outcomes.

Physiological Regulation and Adjustment

As mentioned above, although temperament is a strong predictor for the development of behavioral problems, not all fearful/inhibited or exuberant children develop later internalizing or externalizing behaviors. For example, even though BI is one of the most stable temperament indicators, there is important discontinuity in this index, as many extremely inhibited children display less inhibition and anxiety symptoms later in development (Degnan & Fox, 2007). Therefore, it is imperative to look at what other aspects of children's development interact with temperament to predict maladaptive behaviors. Self-regulation, as a moderator of temperament, has received much attention as a predictor of behavioral problems. Self-regulation is a complex and widely used term that has taken on multiple theoretical and empirical meanings across research laboratories. Some authors have conceptualized aspects of self-regulation as a part of temperament (e.g. Rothbart, 2011). However, based on the definition of temperament previously provided, the present study conceptualized temperament as early emerging individual biologically based differences in reactivity (Kagan & Fox, 2006), and looks at self-regulation as the process by which these differences are modulated. As the study of self-regulation has been approached in several ways, it has also been evaluated in several ways. Many investigations have used questionnaire, behavioral, and physiological measures to assess self-regulation. Another commonly used psychophysiological measure of self-regulation is respiratory sinus arrhythmia (RSA).

RSA (also referred to as vagal tone in the literature) is a measure of the parasympathetic nervous system control of the heart. RSA is measured by the variation of heart rate with respect to the respiration cycle. Reductions in RSA are caused by decreases in input from the vagal nerve during inhalation, increasing heart rate; whereas rises in RSA are due to increases of vagal input during exhalation, resulting in decreases in heart rate. RSA is a measure that reflects the input from the vagal nerve into the heart. Porges' Polyvagal Theory states that this input from the vagal nerve into the heart or "vagal brake" allows the individual to modulate their internal state and actively engage or disengage with the environment as needed in order to regulate their emotion and behavior in an adaptive manner (Porges, 2007). RSA reactivity (change from baseline) is an indication of the individual's adaptation to the environment. Suppression from baseline reflects less input from the vagal nerve allowing more engagement of the sympathetic nervous system. In contrast, augmentation from baseline reflects more input from the vagal nerve, inhibiting the sympathetic nervous system. RSA has been used as an indicator of processes such as attentional, emotional, and cognitive that impact self-regulation (Beauchaine, 2001). In addition, work in infants, toddlers, and young children has focused on RSA as an index of behavioral reactivity and emotionality (Beauchaine, 2001)—hence, its close relation with temperament research.

Consistent with the Polyvagal Theory, it has been shown that high levels of RSA during baseline and RSA suppression during challenging experimental conditions (RSA reactivity) are positively related to emotional regulation and socioemotional competence in children (Calkins & Keane, 2004; Liew et al., 2010). Conversely, low baseline RSA and/or lack of RSA suppression have been associated with poor emotional regulation or

extreme emotional responses (Buss, Goldsmith, & Davidson, 2005; El-Sheikh et al., 2001; Friedman & Thayer, 1998).

RSA and behavioral problems. Based on the studies reviewed above, linking RSA to emotionality and its regulation, it is not surprising that substantial evidence has linked RSA with externalizing and internalizing problems (e.g., Beauchaine, Gatzke-Kopp, & Mead, 2007; Beauchaine, Katkin, Strassberg, & Snarr, 2001; Calkins & Dedmon, 2000; Eisinberg et al., 2011; El-Sheikh & Hinnant, 2011). However, some of these findings have been found in interactions with other characteristics of the child like gender. In addition, several inconsistencies have been found, complicating the interpretation of the findings. Children with low baseline RSA levels show high externalizing problems (e.g., Beauchaine, Gatzke-Kopp, & Mead, 2007; Beauchaine, Katkin, Strassberg, & Snarr, 2001), while other have found this association to be true only for boys (e.g., Beauchaine, Hong, & Marsh, 2008; Calkins & Dedmon, 2000; Eisenberg et al., 2011; El-Sheikh & Hinnant, 2011). Similarly, low baseline has been related to internalizing behaviors (e.g., Forbes, Fox, Cohn, Galles, & Kovacs, 2006; Shannon, Beauchaine, Brenner, Neuhaus, & Gatzke-Kopp, 2007). However, other research has not found baseline RSA to be related to either externalizing or internalizing problems (e.g., Calkins, Graziano, Keane, 2007; El-Sheikh, Hinnant, & Erath, 2011; Gentzler, Santucci, Kovacs, & Fox, 2009; Hastings et al., 2008). Moreover, one study by Dietrich et al. (2007) found that high baseline RSA measured in supine position was associated with more externalizing disorders, particularly for girls.

High levels of RSA suppression have been related most consistently to less externalizing (Calkins & Keane, 2004; Calkins, Blandon, Williford, & Keane, 2007; El-

Sheikh et al., 2001; Graziano, Keane, & Calkins, 2007) and less internalizing problems (Gentzler et al., 2009; Calkins, Graziano, & Keane, 2007). However, some researchers have found this relation to be limited to boys (El-Sheikh et al., 2001; El-Sheikh & Hinnant, 2011; Graziano et al., 2007). More recently, studies have noted the relevance of interactions between RSA baseline and RSA reactivity. For instance, low baseline and high RSA reactivity to an interpersonal challenge predicted an increase in internalizing symptoms over time and low baseline and low RSA reactivity to a cognitive challenge predicted increases in externalizing symptoms (Hinnant & El-Sheikh, 2009). In a similar study from the same research group, boys with low baseline and low RSA reactivity showed an increase in externalizing behaviors across time, whereas other boys with other physiological profile and girls show a decrease across the same two-year time window (El-Sheikh, Hinnant, et al., 2011). In addition, Hastings and colleagues (2008) found that RSA augmentation, and not suppression, to a peer interaction task was associated with less internalizing and externalizing problems. Even though this last finding might seem inconsistent, as interpreted by the authors, it is in agreement with the Polyvagal Theory – a higher RSA baseline reflects a higher capacity for regulation and under a stressful situation, RSA suppression is adaptive since it allows the engagement of the fight-and-flight system (Porges, 2007). On the other hand, if the situation does not require the stress system to be involved and requires social interaction, such as in the free-play task used by Hastings and colleagues (2008), then RSA augmentation would be adaptive since it allows the suppression of the fight-and-flight systems and promotes social engagement behavior (Hastings et al., 2008). However, although playing with same age peers might be a low-stress situation for some children, it might be highly stressful for others.

Therefore, when reviewing this literature, it is not only crucial to evaluate the ecological validity of the experiment and its tasks, but also understand that there might be differences in how the task is interpreted by the child based on his/her individual differences (e.g., gender and/or temperament).

RSA as a protective factor. Patterns of RSA have not only been found to be linked to risk for the development of behavior problems, but it has also been found to serve as a protective factor for individuals at risk. In particular, high baseline RSA has been proposed to serve as a protective factor for children at high risk for behavioral problems (El-Sheikh et al., 2001; El-Sheikh & Whitson, 2006; Katz, 2007). El-Sheikh and colleagues (2001) have found that environmental risk, such as marital conflict (El-Sheikh et al., 2001) or parental drinking (El-Sheikh, 2001), differentially affects children with high baseline RSA compared to those with low baseline RSA. Children with higher baseline did not show as many behavioral problems concurrently compared to the low-baseline children and showed decreased problems longitudinally (El-Sheikh & Whitson, 2006). RSA suppression has also been linked as a protective factor, but not consistently. In the studies previously discussed, El-Sheikh (2001) shows that high RSA suppression to an adult argument had a protective effect on behavioral problems. Nonetheless, in another study, El-Shiekh and colleagues (2001) found the presence of this effect only for boys and not for girls. In contrast, recent studies have found the opposite effect – children with low RSA suppression during cognitive, sensory, and emotional tasks were less affected by environmental risk compared to children with high RSA suppression (Obradović et al., 2010). Nevertheless, recent evidence suggests that these

inconsistencies might be due to the nature of the tasks used to elicit RSA reactivity (Obradović et al., 2011). This evidence will be further discussed below.

RSA stability. As illustrated above, RSA has been widely used as a psychophysiological measure closely related to temperament and regulation. Nonetheless, some of the findings are mixed and in some cases in opposite direction. To add to this complexity, longitudinal studies in RSA have reported mixed findings regarding the stability in the pattern of the measure across time and situations (Calkins & Keane, 2004; El-Sheikh, 2005; Rigterink & Katz, 2010). Individual differences in RSA baseline have been found to be more stable than in reactivity in several samples (Borstein & Suess, 2000; Calkins & Keane, 2004; El-Sheikh, 2005; Rigterink & Katz, 2010). Calkins and Keane (2004) found stability in baseline RSA from 2 years to 4 years of age and modest stability across the same time span in reactivity in four different tasks. In contrast, El-Sheikh (2005) found stability for older children in baseline and stability in reactivity to a cognitive task but no stability in a social task. If RSA reflects a trait-like measure of self-regulation, some stability across time would be expected. Since significant stability has not been consistently found, RSA is thought to be malleable by the environment; however, the feasibility of measuring the impact of the environment on RSA has been questioned because of the dynamic nature of RSA on itself (Katz & Rigterink, 2012).

Measurement and context. There is consensus that the way RSA reactivity is measured, namely what experimental task is used to measure reactivity, affects RSA reactivity (i.e. suppression) and how it is interpreted. Consequently, the differences in the task used by each study might account for the inconsistencies observed in the

literature. As reviewed above, Hastings and colleagues (2008) interpreted RSA augmentation to a social/low stress task as adaptive since the laboratory task used was social in nature. Moreover, in a recent study, Obradović and colleagues (2011) found empirical support for the impact of using different tasks by showing that RSA suppression during cognitive tasks (digit span) moderated differently the impact of maternal risk to behavioral problems than RSA reactivity during an emotional challenge (watching an emotion-evoking movie clip)—children who suppressed in the cognitive task showed more externalizing problems under high-risk conditions. However, children who suppressed during the emotional challenge showed less externalizing problems under high-risk conditions (Obradović et al., 2011). Similar differences in the moderating effects of RSA reactivity according to the task used have been now found by other research groups (e.g., Hinnant & El-Sheikh, 2013). In sum, the difference in how RSA is measured as a potential cause for the inconsistencies in RSA and its relation to problem behaviors has theoretical and empirical foundations. This issue of which task is used may be particularly salient in assessing RSA stability, since this evaluation needs a task that imposes the same emotional or cognitive challenge at the two time points, or two different tasks that are similar in nature and evoke a developmentally appropriate challenge. In order to avoid the subjective selection of specific tasks, the current study used another method to measure RSA reactivity. The current study made use of factor analytic techniques to generate latent variables from several experimental tasks of both cognitive and emotional nature. This study employed two different time points (24 months and 42 months) to evaluate the stability of the shared variance of RSA reactivity to several tasks across these time points.

The present study

As previously discussed, temperament is a predictor for later behavioral problems. This study generated two temperament factors (fear and exuberance) to describe the temperament of each child at 18 months based on maternal reports. The main outcome measured the internalizing and externalizing problems of these children based on maternal report at kindergarten entry (ages 5-6). Moreover, this study analyzed how physiological regulation based on RSA reactivity at two different time points (24-months and 42-months) may moderate relation between the temperament factors and these outcomes. Based on the literature, two main hypotheses were proposed: 1) The exuberant factor would be positively associated with externalizing symptoms and this relation would be moderated by RSA reactivity at both time points – children high in the exuberant factor and with good self-regulation (RSA suppression) would be less likely to develop externalizing symptoms than children with comparable levels in the exuberant factor but with poor self-regulation (RSA augmentation). 2) The fearful factor would be positively associated with internalizing symptoms. In addition, this relation would be moderated by RSA reactivity at both time points, in which children high in the fearful factor and with good self-regulation (RSA suppression) would be less likely to develop internalizing symptoms than children with comparable levels in the fearful factor but with poor self-regulation (RSA augmentation). In addition to the main hypotheses, exploratory analyses were tested as well. As discussed above, there is some evidence demonstrating that the temperamental risk for certain temperamental types might be broader than previously thought, with exuberance predicting also internalizing problems and fear also predicting externalizing behaviors. Hence, the present study evaluated the

relations between the fearful factor to externalizing and the exuberant factor to internalizing outcomes, in addition to the previously mentioned associations (see hypotheses 1 and 2). Finally, in hypotheses 1 and 2, the role of RSA as a moderator was tested at 24- and 42-months of age independently. However, what serves as a protective factor might not be good physiological self-regulation at a particular time point, but may be for the stability across time of physiological self-regulation. Therefore, it was also explored if certain developmental trajectories of physiological self-regulation serve as protective factors for temperamental risk.

Methods

Participants

The data used for the current study was gathered as part of a larger longitudinal study of toddlers' temperament. This larger study aimed to investigate socioemotional development and adjustment from 24 months to school entry. Participants were drawn from a small Northeastern city and surrounding communities via mailings sent to parents identified by local birth records. Interested parents filled out screening questionnaires characterizing their children's emotionality at 18 months. The selected sample for this larger study was oversampled for children who were reported to have high levels of fear. The ethnicity of the selected sample consisted of 90% Caucasian, 1% African American, 1% Hispanic, 5% Asian American, 2% American Indian, 1% Mixed/Other. Most of the sample was middle class (Hollingshead Index: M = 49.72, SD = 10.72, range = 21-66) with 52% of the families having an income above $60,000, and 39% between $31,000 and $60,000. Laboratory evaluations were done at 24 and 42 months of age and

kindergarten entry. Parents completed questionnaires at 18, 24, 36, 42, and 60 months of age. The current study made use of the laboratory assessments at 24 and 42 months, and the questionnaires at 18 months and kindergarten year.

Screening questionnaires were sent to 691 families. Four hundred and eighty five (70%) screening questionnaires were returned. The screening questionnaires consisted of the Infant-Toddler Social and Emotional Assessment (ITSEA; Briggs-Gowan & Carter, 1998; Carter & Briggs-Gowan, 2003) and a six-item wariness questionnaire asking parents about their child's fearfulness to common novel situations (e.g. meeting a mascot). Children were characterized as fearful if they scored one SD above the mean on the wariness questionnaire (based on the first 100 cases) and also either scored one SD above the published mean on the ITSEA internalizing composite or scored one SD above the published mean on two of the following ITSEA subscales: general anxiety, separation distress, and inhibition to novelty. Correlations between the wariness questionnaire and ITSEA scales ranged from r =.25 to r =.53 (all ps<.01). This approach resulted in 125 selected families (63 fearful) seen for the first laboratory visit at 24 months. For the laboratory visit at 42 months, the 18-month screening questionnaires were reviewed to identify and include temperamentally exuberant children. In order to do this, ITSEA measures of positive emotions (reverse scored depression items), activity level/impulsivity, and inhibition to novelty (reverse scored) were used. Children were characterized as exuberant if they were one SD above the mean in at least two of the previously mentioned measures. This approach resulted in 81 children characterized as exuberant in addition to the sample of 125 children seen at 24-months. This resulted in 124 children (43 fearful, 42 exuberant, 39 unselected) for the 42-month laboratory visit.

For the last laboratory visit (age 5-6), 100 families participated in the laboratory visit (38 fearful, 31 exuberant, 31 unselected).

Procedure

Laboratory visit at 24 months. Before the laboratory visit, parents were mailed a packet containing a consent form and several questionnaires. Upon arrival to the lab, parents were given a detailed description of the various laboratory activities their child would be asked to engage in. Parents had the opportunity to ask questions, and then consented to participate in the study. The mailed questionnaires were then collected and another set of questionnaires was provided. During the lab visit, toddlers and their parents (mostly mothers) participated in one neutral baseline task and 6 affective challenge tasks designed to elicit an emotional response. All tasks were videotaped for later scoring and psychophysiological data was collected during these tasks. These activities were modeled after the Laboratory Temperament Assessment Battery (Lab-TAB; Buss & Goldsmith, 2000). All episodes took place in one experimental room with a one-way mirror, which allowed videotaping of the episodes. Parents were with their toddlers during the entire visit, however, they were asked to remain as uninvolved in the tasks as possible unless they thought their toddler needed to be soothed (e.g. high distress). Families were compensated $40 for their participation, and the child was given a small toy.

Episodes. During *Baseline* the child sat quietly for 5 minutes, while coloring a book or reading a book with the experimenter. In *Stranger Working*, a female experimenter entered the room where the child was already playing and sat at a desk in the corner, ignoring the child as she pretended to work. In the *Clown* episode, a different

female experimenter dressed as a clown entered the room and invited the child to play with a variety of toys (e.g., bubbles, beach balls, musical instruments). For the *Puppet Show* episode, the same female experimenter as in the clown episode acted out a puppet show from behind a puppet theatre, inviting the child to interact with the puppets. In the *Stranger Approach* episode, a male experimenter came into the room and verbally interacted with the child for 1.5 minutes. The remaining two episodes exposed the child to novel objects controlled by remote control from the control room. In the *Robot* episode, a one-foot-tall remote control robot moved and made noises randomly on a wooden platform in the corner of the room. In the *Spider* episode, a large stuffed animal spider (placed on top of a remote control car) was driven toward the child and then withdrew to the opposite corner of the room.

Laboratory visit at 42 months. The procedure prior to and at the arrival to the laboratory was similar in design to the procedure of the laboratory visit in the previous age. During this laboratory visit, children and their parents (mostly mothers) participated in one baseline, one episode, and the child participated in two episodes on his/her own. Two tasks were designed to be emotionally challenging and one task was designed to be a cognitive challenge. All episodes took place in the same experimental room as described above. Families were able to observe the child from the control room and were able to get involved in case the child needed it (e.g. high distress). Families were compensated $25 for their participation, and the child was given a small toy.

Episodes. *Baseline* was the same as previously described. *Pop-Up Snakes* was divided in two parts. During the first part (Pop-Up Child), the experimenter surprised the child with a pop-out snakes toy. The snakes jumped out of a can of beans, which the

experimenter was "attempting" to open. In the second part (Pop-Up Parent), the child was told to surprise the parent by having the parent open the can of beans. *Disappointment Task* (DT) was divided into three parts. In the first part (DT Wait), the child was told that he/she was going to receive a gift, but the child had to wait for 30 seconds on his/her own before receiving it. In the second part (DT Wrong), the experimenter gave the child the wrong gift. After receiving the wrong gift, in the third part (DT Resolve), the mother interacted with the child for 60 seconds and the child was then allowed to switch gifts and obtain the correct one. Because each section of the previously described tasks (e.g., DT Wait and DT Wrong) is aimed to elicit a different emotion, each of the sections of the previous episodes was treated as a separate episode from this point forward. In the *Clinical Evaluation of Language Fundamentals* (CELF), the child completed the second edition of this validated verbal assessment (Semel, Wiig, & Scord, 1986).

Measures

Parent report of temperament. The Infant-Toddler Social and Emotional Assessment (Briggs-Gowan & Carter, 1998; Carter & Briggs-Gowan, 2003) is a validated measure of socioemotional problems and competencies composed of 169 items, which are gathered in 20 scales. These scales reflect four broad domains of behavior (Externalizing, Internalizing, Dysregulation, and Competencies). In this measure, the primary caregiver reported on the child's behavior in a 3-point-scale ranging from 0 (Not true/rarely) to 2 (Very true/often). Five scales were selected as indices of temperament (Activity, Impulsivity, Inhibition to Novelty, Sensory Sensitivity, and Attention) as they are believed to reflect emotionality and not competence or maladaptive behaviors.

Sample items of the scales include statements like "is restless and cannot stand still" (Activity; α=0.71), "gets hurt so often you cannot takes your eyes off him/her" (Impulsivity; α=0.51), "takes a while to feel comfortable in new places" (Inhibition to Novelty; α=0.74), "plays with toys for more than 5 minutes" (Attention; α=0.69), or "is bothered by loud noises or bright lights" (Sensory Sensitivity; α=0.50).

Parent report of socioemotional outcomes. In the fall of kindergarten entry, parents and teachers reported on the child's adjustment to kindergarten by using the MacArthur Health Behavior Questionnaire (HBQ; Armstrong, Goldstein, & the MacArthur Working Group on Outcome Assessment, 2003). This measure is designed to measure the physical and mental health and functioning of children (4-8 years-old). The HBQ parent version contains 172 items and the teacher version 115 items. These items are grouped into four domains: Emotion and Behavioral Symptoms, Physical Health, School Adjustment, and Social Adjustment. In the HBQ, the reporter responds in a dichotomous ("yes" or "no") or 3-point Likert scale of 0 ("never or not true"), 1 ("sometimes or somewhat true"), and 2 ("often or very true"). The current study used the Externalizing Symptoms (31 items), and Attention-Deficit/Hyperactivity Disorder (ADHD) Symptoms (15 items) scales for the evaluation of externalizing behaviors. For assessing internalizing behaviors, the Internalizing Symptoms scale (29 items) was used. All of the variables were transformed by taking the square root because they did not have a normal distribution. All of the scales used in the study belong to the Emotion and Behavioral Symptoms domain. Sample items from these scales are "has difficulty awaiting turn in games and groups" or "defiant, talk back to adults"

(Externalizing/ADHD Scale; α=0.92), and "worries about things in the future"(Internalizing Scale; α=0.81).

Physiological data. Measures of the physiological (cardiac and respiratory) data were collected with the use of Mindware WiFi ACQ software, Version 1.0 (Mindware Technologies, Ltd, Westerville, OH) during baseline and the previously described tasks. The collected RSA data was analyzed offline. To accomplish this, the ECG signal was sampled at a rate of 500 ms and bandpass filtered at 40 and 250 Hz. The Mindware editing program Mindware HRV, Version 2.51 identified inter-beat-intervals (IBIs) and detected physiologically improbable intervals based on the overall distribution using a validated algorithm (Berntson, Quigley, Jang, & Boysen, 1990). All data were visually inspected for artifact identification and editing. Using the Mindware HRV program, data were detrended using a first-order polynomial to remove the mean and any linear trends, cosine tapered, and submitted to fast Fourier transform (FFT). RSA was operationalized as the natural log integral of the .24 to 1.04 Hz power band and calculated in 30-second epochs. For baseline and each task, the mean RSA was calculated by averaging across 30-second epochs. In order to calculate RSA reactivity (change from baseline), the obtained baseline-average was subtracted from each of the obtained task-averages, providing a difference score for each episode. Even though this way of assessing reactivity does not control for initial levels of baseline, it was chosen because it is more interpretable when generating groups.

The same procedure was used for the acquisition and analysis of data at the 42-month visit.

Analytic Strategy

Missing data. Missing data was handled by using multiple imputation on SPSS (Version 21), yielding a total of 154 participants. All participants had a temperament score. Hence, only RSA and outcome were imputed. The patterns of missing data for the present study did not violate the assumption that the data was missing completely at random as Little's MCAR test was not significant, χ^2 (10) = 80.272, p = 0.207.

Regression analysis.

Hypotheses. All statistical analyses were performed in SPSS (Version 21). In order to test the main set of hypotheses, the relation between fearful temperament and internalizing problems and its moderation by physiological regulation, a set of hierarchical regressions was completed. To evaluate the role of RSA as moderator, interaction terms were created by centering to the mean the continuous variables and then finding their cross products. Because two different time points were used (24- and 42-months), there were several interaction terms. In order to avoid a large number of predictors in each model and given that RSA scores at both ages were highly correlated (r = .62, p < .05) separate regressions were done for each time point (24- and 42-months), yielding a total of two models. For the first regression model (24-month RSA), the variables were entered in the following order: (step 1) gender and fear (step 2) RSA and the rest of the interactions terms (e.g., Fear x 24m-RSA, Fear x Gender, etc), (step 3) the three-way interaction (Fear x 24m-RSA x Gender). For the second regression, the same procedure was used, substituting the 42-month RSA and its interactions with the fearful factor and gender for the 24-month RSA.

In order to test the second set of hypotheses, the relation between exuberant temperament and externalizing problems and its moderation by good physiological

regulation, the previously described analyses were completed substituting externalizing as the dependent variable for internalizing and exuberance as the independent variable for fear.

Exploratory questions. In order to test the first exploratory question, a temperament group predicting problem behaviors more broadly (namely, the fearful temperament predicting externalizing and the exuberant temperament predicting internalizing problems), another set of hierarchical regressions were performed for each outcome (internalizing and externalizing). For the first regression model (24-month RSA), the variables were entered in the following order: (step 1) gender and the temperament factors (exuberant and fearful), (step 2) RSA and the rest of the interactions terms (e.g., Exuberant x 24m-RSA, Fearful x 24m-RSA, Exuberant x Gender, etc), (step 3) all the three-way interactions (Exuberant x 24m-RSA x Gender and Fearful x 24m-RSA, Gender). For the second regression, the same procedure was used, substituting the 42-month RSA and its interactions with the temperament factors and gender for the 24-month RSA.

Finally, with the purpose of evaluating the third exploratory question of examining the moderating role of the regulatory trajectories of children, four groups were formed based on RSA reactivity. Suppression was defined as having a value lower than zero or no difference from baseline and augmentation by having a value greater than zero. Group 1 was composed of the children that suppressed RSA at both time points. Group 2 was comprised of the children that suppressed RSA only at 24-months. Group 3 was composed of the children who suppressed RSA only at 42-months. Finally, group 4 was represented by children who did not suppress RSA at both time points. In order to

test if these groups differed in levels of externalizing or internalizing a one-way ANOVA was performed for each outcome. In order to test if these groups moderated the relation between temperament and socioemotional outcomes, dummy variables were created for these groups. The suppression group was selected as the reference group as it had the largest sample size, and because it is considered the "typical" adaptive response to the kind of laboratory challenges used in this study, facilitating the interpretation of the comparison. The dummy variables for temperament group and RSA group were entered into a hierarchical regression with their respective interactions with the exuberant and fearful factors. Post hoc analyses were done in order to further evaluate any significant effect.

Results

Data Reduction

Temperament. In order to obtain temperamental dimensions, an exploratory factor analysis was performed using the five ITSEA scales previously mentioned. An exploratory factor analysis was used because the primary purpose was to identify and compute factor scores for the major factors underlying these five ITSEA scales. All of the screened children (not only the selected children) were used in this analysis in order to avoid selection bias. The first factor had an eigenvalue of 1.9 (37%); the second had an eigenvalue of 1.2 (23%); the third had an eigenvalue of 0.8 (17%); and the other last two factors had eigenvalues under 0.7. Factors with an eigenvalue greater than one were kept and used for future analyses. The extracted two factors explained 60% of the variance. This orthogonal solution was further tested by using varimax and oblimin

rotations, which did not show a significant difference in the factors and their loadings. All five scales had loadings higher than 0.6. Hence, no scales were deleted. As shown in Table 1, the scales Activity and Impulsivity loaded positively into the first factor. The Attention scale loaded negatively into the first factor. As mentioned in earlier previous research (Fox et al., 2001) found similar characteristics for the exuberant temperament; hence, this factor was labeled Exuberance and factors scores were created from this factor. The scales of Inhibition to Novelty and Sensory Sensitivity loaded positively onto the second factor. Consistent with the literature previously reviewed (Buss, 2011; Kagan & Fox, 2006), this factor was labeled Fear and factor scores were created for this factor.

RSA. In order to obtain latent variables for each time point when RSA was collected, an exploratory factor analysis was performed on the six difference scores. This was done at each time point separately. This way, the shared variance in RSA reactivity across all different tasks for each occasion was estimated in order to identify the underlying factor. For 24-months, all six residualized change scores loaded into one factor (eigenvalue of 3.4; 57.4% of variance explained). This factor was called RSA at age 2 (RSA-24m). For 42-months, all six difference scores loaded into one factor (eigenvalue of 3.6; 59.4% of variance explained). This factor was called RSA at age 3.5 (RSA-42m). Figure 1 illustrates the latent variables, their loadings to their respective measures, and the relation among the two factors. The factor obtained at each age was used to estimate factors scores. The estimated factor scores were for the interaction terms in the previously described regression analyses.

Descriptive Statistics and Bivariate Relations

Descriptive statistics for all key variables are shown in Table 2. As shown in Table 2, the exuberance temperament factor was positively associated with externalizing symptoms, $r(152) = .38$, $p < .05$, as well as with RSA reactivity at 42 months, $r(152) = .18$, $p < .05$. The fearful temperament factor was positively associated with internalizing symptoms, $r(152) = .18$, $p < .05$. RSA reactivity was not associated with internalizing or externalizing.

Main Hypotheses

The results from the hierarchical regressions used to test the main hypotheses are shown in Table 3. The first hypothesis expected exuberance to predict externalizing behaviors and that this relation would be moderated by the two RSA time points – children high in the exuberant factor and with good self-regulation (RSA suppression) would be less likely to develop externalizing symptoms than children with comparable levels in the exuberant factor but with poor self-regulation (RSA augmentation). For the second hypothesis, it was predicted that fear would predict internalizing problems and that this relation would be moderated by the two RSA time points - children high in the fearful factor and with good self-regulation (RSA suppression) would be less likely to develop internalizing symptoms than children with comparable levels in the fearful factor but with poor self-regulation (RSA augmentation).

Predicting Externalizing with Exuberance and 24m-RSA. In step one of the first regression, the variance accounted for by the two independent variables was .145 (adjusted $R^2 = .134$), which was significantly different from zero, $F(2, 151)=12.81$, $p = .001$. In this step, the exuberance factor was the only significant predictor, $\beta = .39$, $p = .001$. In step 2, RSA and all second level interactions were entered. The change in

variance accounted in this step (ΔR^2 =.006) did not differ from zero. In this step, only the exuberance factor was significant, β = .30, p = .012. In the third step, the three-way interaction was entered, which explained .027 of the variance. This change in explained variance was significant, $F(1, 146)$=4.80, p = .030. In this step, exuberance was a significant predictor, β = .34, p = .004, as well as the three-way interaction between exuberance, RSA, and gender, β = -.37, p = .030. This interaction, and all of the following, was probed using the simple slope procedure suggested by Aiken and West (1991). In this procedure, the levels of externalizing according to the level in exuberance are compared at high (i.e., 1 *SD* above the mean) and low (i.e., 1 *SD* below the mean) levels of 24m-RSA for boys and girls separately. This procedure demonstrated that the two-way interaction between exuberance and RSA was significant for girls (t = -2.7, p = .008), but only marginally significant for boys (t = 1.9, p = .059). As illustrated in Figure 2, exuberance was predictive of externalizing behaviors only when children suppressed RSA, t = 4.3, p = .001. Even though for boys the interaction was only marginally significant (p = .059), the opposite was true – as shown in Figure 3 – exuberance was predictive of externalizing when children augmentated RSA, t = 3.6, p = .001.

Predicting Externalizing with Exuberance and 42m-RSA. The first step of this regression is identical to the one described above with 24-m RSA. For the second step, the change in explained variance (ΔR^2 =.014) was not significant from zero. However, the overall model was still significant, $F(6, 147)$=4.80, p = .001. In this step the exuberance factor was the only significant predictor, β = .28 , p = .013. In the third step, the change in accounted variance was not significant (ΔR^2 =.017), but the overall model remained significant, $F(7, 146)$=4.47, p = .001. In this step only exuberance was

significant, β = .32, p = .010. However, the three-way interaction was marginally significant, β = -.31, p = .086. This interaction will be discussed in the exploratory models as it reached significance then.

Predicting Internalizing with Fear and 24m-RSA. In step 1, the variance accounted for by the three independent variables was .03 (adjusted R^2 = .03), which was not significantly different from zero ($F(2, 151)$=1.8, p = .074), making the overall model not significant as well. In this step, the fearful factor was the only significant predictor, β = .19, p = .024. In step 2 and 3, as RSA, second level interactions, and third order interactions were entered, the models were not statistically significant and none of the interactions or predictors reached significance in these steps.

Predicting Internalizing with Fear and 42m-RSA. The first step is the same as the one described above for 24-m, and hence, the results were the same. Similarly to the regression with 42-m, the second and third steps were not significant.

Exploratory Analyses

In addition to the main hypotheses, exploratory analyses tested if temperament associations were broader than previously thought, with exuberance also predicting internalizing problems and fear predicting externalizing behaviors. In addition, it was evaluated if these relations were moderated by RSA.

Predicting Externalizing with Exuberance, Fear, and 24m-RSA. The results from the hierarchical regressions are depicted in Table 4. These results indicate that in step 1 the variance accounted for by the three independent variables was .166 (adjusted R^2 = .149), which was significantly different from zero, $F(3, 150)$=9.96, p = .001. The exuberance factor was the only significant predictor in this step, β = .39, p = .001. In step

2, RSA and all second level interactions were entered. The change in variance explained in this step (ΔR^2 =.05) did not significantly differ from zero. In this step, the exuberance factor was significant, β = .30, p = .001, as well as the interaction between fearful temperament and RSA, β = .19, p = .008. In step 3, the two three-way interactions were added to the model. The change in variance accounted for in this step equaled .10, which was significantly different from zero, $F(2, 142)$=10.7, p = .001. In the third step, the significant independent variables were the exuberance factor, β = .34, p = .002, the three-way interaction between exuberance, RSA, and gender, β = -.37, p = .001, and the three-way interaction between fear, RSA, and gender, β = -.39, p = .001. The interaction with exuberance was probed and discussed above (see Main Hypotheses and Figure 2). Similarly to exuberance, the relation between the fearful factor and externalizing was only significant at RSA suppression (t = 4.3, p = .001) for girls. This interaction is depicted in Figure 2.

Predicting Internalizing with Exuberance, Fear, and 24m-RSA. In step 1 of this hierarchical regression, the variance accounted for by the three independent variables was .03 (adjusted R^2 = .05), which was not significantly different from zero, $F(3, 150)$=1.8, p = .154. In this step, the fearful factor was the only significant predictor, β = .19, p = .023. In step 2 and 3, as RSA, second level interactions, and third order interactions were entered, the models were not statistically significant and none of the interactions or predictors reached significance in these steps.

Predicting Externalizing with Exuberance, Fear, and 42m-RSA. In the same manner to the results of the 24-month old RSA reactivity regression, the first step of this

regression explained .166 (adjusted R^2 = .149) of the variance, which was significantly different from zero, $F(3, 150)$=9.96, p = .001. In this step, the exuberance factor was the only significant predictor, β = .39, p = .001. In step 2, the change in explained variance was not significant and none of the added variables reached significance, making only the exuberance factor significant, β = .28, p = .017, in this step. However, in step 3, the overall model and the change in explained variance were significant (ΔR^2 =.07), $F(2, 142)$=6.84, p = .001. In this step, the significant independent variables were the exuberance factor, β = .32, p = .006, the three-way interaction between exuberance, RSA, and gender, β = -.31, p = .005, and the three-way interaction between the fearful factor, RSA, and gender, β = -.32, p = .002. In probing these interactions, the two-way interaction between exuberance and RSA was significant only for girls (t = -2.1, p = .041). As shown in Figure 4, exuberance was only predictive of externalizing behaviors at RSA suppression (t = 4.1, p = .001). Similarly, the interaction with the fearful factor and RSA was only significant for girls (t = -2.1, p = .01). Thus, the fearful factor was only predictive of externalizing behaviors at RSA reactivity suppression, t = 3.3, p = .002.

Predicting Internalizing with Exuberance, Fear, and 42m-RSA. In the same manner as the 24-month old RSA reactivity, in the first step of this hierarchical regression, the variance accounted for by the three independent variables was .03 (adjusted R^2 = .05). This was not significantly different from zero ($F(3, 150)$=1.8, p = .154), and in this step, the fearful factor was the only significant predictor, β = .19, p <

.023. In step 2 and 3, the models were not statistically significant and none of the interactions or predictors reached significance in this step either.

RSA Trajectories Predicting Externalizing and Internalizing

In addition, it was tested if the stability across time of physiological self-regulation, as opposed to a specific time-point, would moderate the relation between temperament and socioemotional outcomes. Therefore, it was also explored if certain developmental trajectories of physiological self-regulation serve as protective factors for temperamental risk.

Children were characterized in four groups according to their physiological reactivity at each time point. There were 63 children who showed suppression at both time points (referred to as the suppression group hereafter); 62 who did not suppress at both time points (referred to as the augmentation group hereafter); 17 who showed suppression in the first time point but not the second one (referred to as the suppress-augment group hereafter); and 12 who displayed no suppression at the first time point but did at the second time point (referred to as the augment-suppress group hereafter). The mean in externalizing and internalizing for each group is shown in Table 5. There were no differences between groups in externalizing or internalizing. Nevertheless, the hierarchical regressions illustrated in Table 4, show that the relation between temperament and socioemotional outcomes differed between the groups. No interactions were tested with gender due to the small sample size of the suppress-augment and augment-suppress groups.

Predicting Externalizing. In a similar manner to the previously discussed results, the first step of this regression explained .162 (adjusted R^2 = .151) of the

variance, which was significantly different from zero ($F(2, 151)$=14.62, p = .001). In this step, the exuberance factor was the only significant predictor, β = .39, p = .001. In step 2, the dummy coded group variables were added. In this step, only the exuberance factor was significant, β = .39, p = .001. The change in explained variance was not significant in this step. However, in step 3, the overall model and the change in explained variance were significant (ΔR^2 =.08), $F(6, 142)$=6.84, p = .024. In this step, the significant independent variables were the exuberance factor, β = .46, p = .001, the interaction between fear and the augmentation group, β = -.32, p = .006, the interaction between the fearful factor and augment-suppress group, β = -.18, p = .043, and the interaction between the fearful factor, and the suppress-augment group, β = -.17, p = .036. In order to probe these interactions, the relations between exuberance and inhibition for each group are shown in Table 5. As it can be observed, a positive relation between the fearful factor and externalizing was only present for the suppression group, which was set as the reference group. Given that this group was compared to all other groups, in which no such relation was present, all the interactions with the fearful factor were significant.

Predicting Internalizing. As shown in Table 4, in the first step of this regression, the variance explained was .03 (adjusted R^2 = .02), making the overall model only marginally significant ($F(2, 151)$= 2.51, p = .08). The fear factor was the only significant predictor, β = .19, p = .025. In the second step, as the dummy-coded group variables were added, there was no significant change in explained variance (ΔR^2 =.02) and the overall model was not significant. The fearful factor was the only significant predictor, β = .23, p = .019. In the third step, the change in variance explained was

marginally significant (ΔR^2 = .07), *F(6, 142)*=1.84, *p* = .096, and the overall model was marginally significant was well, *F(11, 142)*= 1.78, *p* = .062. In this step, the only significant predictor was the interaction between the fearful factor and the suppress-augment group, β = -.18, *p* = .048. This interaction was probed in the same way as the one above. As illustrated in Table 5, a positive relation between fear and internalizing was only present for the suppress-augment group, making it significantly different from the suppress group which showed no relation.

Discussion

The purpose of the present study was to examine the relation between infant temperament factors and externalizing and internalizing behaviors at kindergarten entry, as well as the potential moderation of these longitudinal relations by RSA reactivity. As expected, and consistent with the previous literature, the findings indicate that temperament is a significant predictor of socioemotional outcomes, but this link can be moderated by its interaction with gender and RSA reactivity.

Exuberance, RSA, and Gender Predict Externalizing

It was hypothesized that exuberance would be predictive of externalizing behaviors. This hypothesis was supported by the results showing that the exuberance factor was a strong predictor of externalizing problems. This result is in line with previous literature (e.g., Martel et al., 2007; Putnam & Stifter, 2005; Stifter et al., 2008; Tackett, Martel, & Kushner, 2012 for a review), which links the exuberant temperament with externalizing behaviors. However, this relation was moderated by the child's gender and RSA reactivity at 24- and 42-months of age. The temperament by 24m-RSA reactivity interaction was only significant for girls, such that RSA suppression and high

exuberance predicted more externalizing symptoms. In contrast, for girls who displayed RSA augmentation, the relation between exuberance and externalizing was not present. This is contrary to what some studies have previously reported that RSA suppression served as a protective factor in the context of environmental risk factors (e.g., El-Sheik, 2001; El-Sheik et al., 2001; Katz et al., 2007). However, it is consistent with other literature that finds RSA augmentation as a buffer to environmental risk for externalizing and internalizing problems (e.g., Cipriano, Skowron, & Gatzke-Kopp, 2011; Obradović et al., 2010; Obradović et al., 2011). These last findings have been interpreted as support to the differential susceptibility concept or the biological sensitivity to context theory by showing that children who are more reactive (as reflected by RSA suppression) tend to be more affected by their environment (Ellis, Boyce, Belsky, Bakermans-Kranenburg, & van Ijzendoorn, 2011). This way, high-reactive children show worse functioning under adverse conditions, but the best functioning under advantageous environment. However, the present results cannot be interpreted in this manner because the environment was not considered in these analyses – an important future direction.

On the other hand, when probing the same interaction for boys a different pattern emerged. Even though this two-way interaction was only marginally significant, RSA augmentation acted as a risk factor and high RSA reactivity buffered the exuberance-externalizing relation. Comparable results were recently found by Hinnant & El-Sheikh (2013), who observed that girls with RSA suppression were more likely to be in a profile characterized by high externalizing and high internalizing symptoms across three different time points; whereas boys were more likely be in the profile if they displayed low RSA reactivity/RSA augmentation (Hinnant & El-Sheikh, 2013). In addition, similar

gender differences were observed in Obradović et al. (2010), in which high RSA reactivity was related to positive outcomes for boys, but for girls, low RSA reactivity was related to the same positive outcomes. Hence, analogous to the conclusions reached by Obradović and colleagues (2010), these findings highlight the importance of considering the role of gender when examining RSA reactivity and its relations to other predictors of psychopathology and socioemotional adaptation.

Importantly, a similar pattern emerged when using RSA at 42-months. However, in this model, the three-way interaction was only marginally significant and is further discussed below with the exploratory analyses.

Fear Predicts Internalizing

It was hypothesized that the fearful temperament factor would predict internalizing behaviors. The results showed that the fearful factor was the sole predictor of internalizing problems. This result supports a large corpus of literature, which shows that fearful temperament is one of the best predictors of later internalizing symptoms (e.g., Buss, 2011; Caspi et al., 2003; Chronis-Tuscano et al., 2009; Hirshfeld, et al., 1992; Schwartz, Snidman, & Kagan, 1999; Stifter, Putnam & Jahromi, 2008; Pérez-Edgar & Fox, 2005 & Klein, Dyson, Kujawa, & Kotov, 2012 for reviews). However, the regression models including RSA and the interaction of RSA with fearful temperament did not reach significance. The potential causes for the lack of results with RSA are discussed below. A potential explanation for the lack of interactions with RSA to predict internalizing is that self-regulation as indexed by RSA might not be as salient of a predictor as it is for externalizing, which is marked by low self-regulatory capacities. Other child characteristics might be better moderators of the relation between fearful

temperament and the development of internalizing behaviors (e.g., attention bias towards threat; Pérez-Edgar et al., 2010; 2011). In addition, the developmental period in which the socioemotional outcomes were evaluated (the transition to kindergarten) might be of particular relevance to externalizing problems rather than internalizing problems, as it is the beginning of the academic life. As children enter school, the demands for self-control are increased, potentially highlighting externalizing behaviors.

Inhibition, Exuberance, RSA, and Gender Predict Externalizing

Because if was of interest to explore broader associations between temperament and socioemotional outcomes, inhibition and its interactions with RSA were tested while controlling for exuberance. The interactions with exuberance were maintained even when the fearful factor and its interactions were added; in fact, the three-way interaction between exuberance, 42m-RSA, and gender, moved from marginally significant to significant. In an analogous way to the interaction discussed above with 24m-RSA, there was a positive relation between the exuberance factor and externalizing problems only for girls with RSA suppression at this age.

Interestingly, after accounting for gender and exuberance, the fearful factor was marginally predictive of externalizing behaviors. However, this main effect was further specified by the three-way interactions between fear-by-24m-RSA reactivity-by-gender and fear-by-42m-RSA-by-gender. Both interactions behaved in the same way at both ages. In a similar way to exuberance, this interaction was only significant for girls, in which only girls with high RSA reactivity showed a positive relation between the fearful temperament and externalizing behaviors. Although this relation was not expected as part of the main hypotheses, and it is contrary to most studies showing that fearful

temperament is a protective factor for the development of externalizing problems (e.g., Schwartz, Snidman, & Kagan, 1996). The positive relation between the fearful temperament and externalizing has several post-hoc explanations. First, externalizing and internalizing symptoms are comorbid (Angold, Costello, & Erkanli, 1999; Lilienfeld, 2003) and in the current study externalizing and internalizing symptoms were significantly correlated (r = .39). In addition, studies of comorbidity in childhood have shown that boys tend to show trajectories of pure externalizing (Fanti & Henrich, 2010) compared to girls who tend to display trajectories in which externalizing and internalizing covary more closely (Wiesner & Kim, 2006). The comorbidity observed in our study could be due to several factors. The first is methodological; in which, the instrument used to measure psychopathology might not effectively discriminate between disorders. For example, parents can overestimate the covariation between internalizing and externalizing because of implicit personality theories in a comparable way to the halo effect, or sampling bias – given that the sample used was oversampled for highly fearful and exuberant children, it is more likely to show behavioral problems not only in one dimension but in both (see below). Another reason is the developmental period that internalizing and externalizing were assessed – a period in which disorders are not fully differentiated, increasing the rates of comorbidity (Lahey et al., 2008; Lilienfeld, Waldman, & Israel, 1994; Sterba et al., 2010). For example, Lahey et al. (2008) found that factors of DSM-IV became slightly more differentiated with age and in boys. Similarly, Sterba and colleages (2010) also found slight differentiation with age; however not enough to explain the comorbidity observed in their sample, implying that psychopathological differentiation across development is not the sole, or even major

cause of the comorbidity rates present at this period of development. A way in which this can be illustrated for the present sample is that children high in fear, who were higher in internalizing symptoms, might "act-out" their symptoms with temper tantrums and reactive aggression, refuse requests from parents (e.g., school refusal behavior or not joining other children to play), as well as not doing good at school due to these anxieties, leading parents to rate them as having conduct problems, defiant or with deficits in attention. In fact, anxiety has been related to externalizing disorders (Bubier & Drabick, 2009 for a review), especially in social anxiety, generalized anxiety disorder, and separation anxiety (Marmorstein, 2007). This way, the fearful temperament, particularly at the extreme in girls who are highly reactive, might be related to externalizing behaviors.

Exuberance, Inhibition, RSA, and Gender Predict Internalizing

When exploring the exuberant and its interactions as a predictor of internalizing while controlling for fear, the exuberant factor and its interactions were not a significant predictor of internalizing. In addition, all the models remained not significant, making fear the only predictor of internalizing. Potential explanations for the lack of findings with RSA in predicting internalizing were discussed above.

It is also important to note that this study does not provide support for the other set of outcomes exuberant temperament has been related to, namely sociability. This is possibly due to the fact that internalizing was evaluated as anxiety-related behaviors and depression, not by problems with peers or social withdrawal. If the latter were the case, a negative relation between exuberance and internalizing would be expected. In addition, the exuberance factor did not include a scale of sociability or positive affect, which have

been shown to act as a protective factor of externalizing. On the other hand, the exuberance factor used was mostly composed by activity levels and impulsivity. Hence, it is not surprising that the relations between exuberance and sociability outcomes were not present in this study.

RSA stability. The consistency between the results at the two ages RSA was evaluated is not surprising given that, in this study, RSA reactivity showed high stability (r = .62). Findings on the stability of RSA has been mixed in previous literature, especially RSA reactivity. The author suggests that the method by which RSA reactivity was estimated may be important to consider. By using a factor analytic approach of RSA reactivity across several different tasks, the RSA reactivity factor score in the current study represented a more global/trait-like measure of reactivity. Most studies in the literature rely on a reactivity score from just one task, Thus, assessing stability across development may be more difficult given that a task of equivalent emotional valence and magnitude is needed at two or more developmental time-points. The factor analytic approach is not affected by this problem as much given that it is more trait-like. Preliminary analyses support that the factor analytic method is consistent with a trait approach (Morales, Beekman, Davis, & Buss, 2012). This measure of RSA reactivity was related to parental reports of temperament, whereas using the score of just one task related to the observed behaviors during that task, but not to temperament reports. This implies that the single task RSA reactivity is an indicator of behavior during that specific situation and context, but not necessarily of trait-like behavioral reactivity (Morales, Beekman, Davis, & Buss, 2012). Consequently, when conceptualizing physiological reactivity, it is not only important to note the kind of task that is being used to elicit

physiological reactivity (Obradovíc et al., 2011), but also take special consideration on the way that reactivity is being estimated (Obradovíc & Burt, 2012).

Exploratory Analyses with RSA Trajectories

Even though it is common to test RSA reactivity as a predictor of socioemotional outcomes or a moderator between other predictors and these outcomes. This is commonly done by using RSA reactivity at one time point in development. For this reason, the present study explored the possibility of RSA trajectories as predictors or moderators of the relation between temperament and socioemotional outcomes. To the author's knowledge, this question has not been explored. Although, recent studies have tested the relations between RSA baseline, RSA reactivity, and their interaction to trajectories of socioemotional outcomes (e.g., El-Sheikh et al., 2011; Hinnant & El-Sheikh, 2013; Hinnant & El-Sheikh, 2009). The closest have been studies like El-Sheikh and Hinnant (2011), in which the impact of marital conflict on the trajectory of baseline RSA as a measure of allostatic load was tested (El-Sheikh & Hinnant, 2011). The results of this study show that even though there were no mean differences in externalizing or internalizing among the trajectory groups, the relation between temperament and later socioemotional outcomes were different between trajectory groups. The difference, the fearful factor positively predicts externalizing in the suppression group, is in line with the interactions previously discussed, which were true for girls. In fact, when the suppression group was divided by gender as a post hoc analysis, this relation was only true for girls and not for boys (analysis not shown), illustrating that this finding is in concordance with the ones previously discussed. Second, the positive relation between the fearful factor and internalizing was present only for the suppress-augment group, is

also in line with the main effect of the fearful factor discussed before and with the previous cited literature that has found similar effects. I remain hesitant to further interpret this finding given that the overall model is only marginally significant and due to the lack of literature in RSA trajectories to ground this finding. However, these exploratory analyses speak for the potential of exploring RSA reactivity trajectories as a possible moderator of predictors of socioemotional outcomes, especially when utilizing more data points in the trajectories.

Overall, these findings suggest important gender differences in the process of physiological regulation used to cope with the cognitive and emotional challenges like the ones used in the current study. As interpreted by Hinnant & El-Sheikh (2013), for girls, showing high RSA reactivity towards these tasks was maladaptive, suggesting that a strong parasympathetic response towards stress was associated with more externalizing problems when a temperamental predisposition was already present – possibly indicating overarousal or dysregulation towards stressors as suggested by an excessive physiological response, which has been related with a sympathetic (flight–fight) response (Beauchaine, 2001). On the other hand, for boys showing a lack of physiological response predicted externalizing problems at high levels of exuberance – possibly signifying lack of engagement with the challenge via lack of active allocation of attentional resources and emotional engagement, which are important in academic and socioemotional competence.

Limitations

It is important to consider the findings and interpretations of this study in light of its limitations. The first limitation is that both the predictor (temperament) and the

outcome (internalizing and externalizing) were based on maternal reports. Hence, it is affected by single-method biases such as parents reporting on similar behaviors in both questionnaires – which would cause the observed relation between temperament and socioemotional outcomes because of stability of behavior rather than temperament predicting behavior problems. Nevertheless, the author attempted to reduce these biases by carefully selecting scales that did not overlap between the predictor and the outcome. For example, scales from the Social Relations factor (such as the Peer Relations and Social Withdrawal scales) were not used as an outcome because of the similarity with some of the items used in the Inhibition to Novelty scale in the temperament factors. In addition, no behavioral, psychological, or environmental data was considered in order to evaluate the potential mediators of the discussed associations or to corroborate some of the interpretations offered. An important future direction will be to corroborate the interpretations offered by using the behavioral observations gathered during the tasks used to elicit the physiological response. In addition, exploring potential mediators or moderators of these longitudinal associations would be of interest as well. Such mediators or moderators could be environmental or psychological factors (e.g., marital conflict; El-Sheikh & Hinnant, 2011) as well as measures that index other physiological systems (e.g., cortisol; El-Sheikh, Arsiwalla, Hinnant, & Erath, 2011) that have been documented to impact the outcomes of interest as well as physiological reactivity itself, generating more complex interactions.

A second limitation is that this study used composites of externalizing and internalizing problems as outcomes, blurring potential interesting disorder-specific associations with temperament and physiological reactivity. These more specific

associations would be of particular interest for forthcoming investigations in an attempt to better explain the comorbidity found in this and other studies when even using these broader composites of symptoms. Another important limitation to consider is the relatively small sample size, which might impact the power to detect some of the complex interactions explored in this study as well as impact the confidence in the findings actually observed (Button et al., 2013). However, the fact that these analyses were performed in several ways such as using temperament groups instead of a continuous measure, using residualized change scores for RSA reactivity, or imputing missing data via different methods yielding the same general findings; together with the similar results recently found by other research groups, gives the author confidence regarding the main results of this study. A significant shortcoming of this study is the lack of diversity in the sample used, which greatly limits the generalization of the findings to other populations. Future studies should test if similar results are present in other ethnicities and cultures. Finally, this study uses a relatively early window in the development of socioemotional outcomes. Prospective longitudinal studies are needed in order to test if these results extend to the developmental stages where the emergence of externalizing and internalizing behaviors are more prevalent.

Conclusion

This study provides several interesting findings. First is support for the large corpus of evidence showing a strong relation between early temperament and socioemotional problems. Second, the relation between temperament and externalizing problems can be moderated by physiological measures believed to index self-regulation processes. However, it was also observed that these processes might act in a different

manner in boys and girls, highlighting the importance of exploring the contributions of gender in forthcoming investigations. Finally, this study provides some new findings that expose the potential role of physiological trajectories as moderators of the relations between socioemotional outcomes and their predictors. These findings hope to encourage future investigations to test similar longitudinal relations in order to increase our knowledge of the complex interplay between infant temperament and physiological indices of self-regulation across development to better understand socioemotional disorders.

References

Aiken, L. S., West, S. G., & Reno, R. R. (1991). *Multiple Regression: Testing and Interpreting Interactions*. SAGE.

Angold, A., Costello, E. J., & Erkanli, A. (1999). Comorbidity. *Journal of Child Psychology and Psychiatry*, *40*(1), 57–87. doi:10.1111/1469-7610.00424

Armstrong JM, Goldstein LH, The MacArthur Working. Group on Outcome Assessment (2003), *Manual for the MacArthur Health and Behavior Questionnaire (HBQ 1.0). MacArthur Foundation Research Network on Psychopathology and Development (David J. Kupfer, Chair).* Pittsburgh: University of Pittsburgh

Beauchaine, T. (2001). Vagal tone, development, and Gray's motivational theory: Toward an integrated model of autonomic nervous system functioning in psychopathology. *Development and Psychopathology*, *13*(2), 183–214. doi:10.1017/S0954579401002012

Beauchaine, T. P., Gatzke-Kopp, L., & Mead, H. K. (2007). Polyvagal Theory and developmental psychopathology: Emotion dysregulation and conduct problems from preschool to adolescence. *Biological Psychology*, *74*(2), 174–184. doi:10.1016/j.biopsycho.2005.08.008

Beauchaine, T. P., Katkin, E. S., Strassberg, Z., & Snarr, J. (2001). Disinhibitory psychopathology in male adolescents: Discriminating conduct disorder from attention-deficit/hyperactivity disorder through concurrent assessment of multiple autonomic states. *Journal of Abnormal Psychology*, *110*(4), 610–624. doi:http://dx.doi.org.ezaccess.libraries.psu.edu/10.1037/0021-843X.110.4.610

Berntson, G. G., Quigley, K. S., Jang, J. F., & Boysen, S. T. (1990). An Approach to Artifact Identification: Application to Heart Period Data. *Psychophysiology*, *27*(5), 586–598. doi:10.1111/j.1469-8986.1990.tb01982.x

Bornstein, M. H., & Suess, P. E. (2000). Child and mother cardiac vagal tone: Continuity, stability, and concordance across the first 5 years. *Developmental Psychology*, *36*(1), 54–65. doi:10.1037/0012-1649.36.1.54

Briggs-Gowan, M. J., & Carter, A. S. (1998). Preliminary acceptability and psychometrics of the infant–toddler social and emotional assessment (ITSEA): A new adult-report questionnaire. *Infant Mental Health Journal*, *19*(4), 422–445. doi:10.1002/(SICI)1097-0355(199824)19:4<422::AID-IMHJ5>3.0.CO;2-U

Bubier, J. L., & Drabick, D. A. G. (2009). Co-occurring anxiety and disruptive behavior disorders: The roles of anxious symptoms, reactive aggression, and shared risk processes. *Clinical Psychology Review*, *29*(7), 658–669. doi:10.1016/j.cpr.2009.08.005

Buss, K. A. (2011). Which fearful toddlers should we worry about? Context, fear regulation, and anxiety risk. *Developmental Psychology*, *47*(3), 804–819. doi:10.1037/a0023227

Buss, K. A., Hill Goldsmith, H., & Davidson, R. J. (2005). Cardiac reactivity is associated with changes in negative emotion in 24-month-olds. *Developmental Psychobiology*, *46*(2), 118–132. doi:10.1002/dev.20048

Button, K. S., Ioannidis, J. P. A., Mokrysz, C., Nosek, B. A., Flint, J., Robinson, E. S. J., & Munafò, M. R. (2013). Power failure: why small sample size undermines the reliability of neuroscience. *Nature reviews. Neuroscience*, *14*(5), 365–376. doi:10.1038/nrn3475

Calkins, S. D., Blandon, A. Y., Williford, A. P., & Keane, S. P. (2007). Biological, Behavioral, and Relational Levels of Resilience in the Context of Risk for Early

Childhood Behavior Problems. *Development and Psychopathology*, *19*(03), 675–700. doi:10.1017/S095457940700034X

Calkins, S. D., Graziano, P. A., & Keane, S. P. (2007). Cardiac vagal regulation differentiates among children at risk for behavior problems. *Biological Psychology*, *74*(2), 144–153. doi:10.1016/j.biopsycho.2006.09.005

Calkins, S. D., & Keane, S. P. (2004). Cardiac vagal regulation across the preschool period: Stability, continuity, and implications for childhood adjustment. *Developmental Psychobiology*, *45*(3), 101–112. doi:10.1002/dev.20020

Carter, A. S., Briggs-Gowan, M. J., Jones, S. M., & Little, T. D. (2003). The Infant-Toddler Social and Emotional Assessment (ITSEA): Factor Structure, Reliability, and Validity. *Journal of Abnormal Child Psychology: An official publication of the International Society for Research in Child and Adolescent Psychopathology*, *31*(5), 495–514. doi:10.1023/A:1025449031360

Caspi, A., Harrington, H., Milne, B., Amell, J. W., Theodore, R. F., & Moffitt, T. E. (2003). Children's Behavioral Styles at Age 3 Are Linked to Their Adult Personality Traits at Age 26. *Journal of Personality*, *71*(4), 495–514. doi:10.1111/1467-6494.7104001

Caspi, A., & Silva, P. A. (1995). Temperamental Qualities at Age Three Predict Personality Traits in Young Adulthood: Longitudinal Evidence from a Birth Cohort. *Child Development*, *66*(2), 486–498. doi:10.1111/j.1467-8624.1995.tb00885.x

Chronis-Tuscano, A., Degnan, K. A., Pine, D. S., Pérez-Edgar, K., Henderson, H. A., Diaz, Y., Raggi, V. I., & Fox, N. A. (2009). "Stable early maternal report of behavioral inhibition predicts lifetime social anxiety disorder in adolescence". Journal of the American Academy of Child and Adolescent Psychiatry (0890-8567), 48 (9), p. 928.

Degnan, K. A., & Fox, N. A. (2007). "Behavioral inhibition and anxiety disorders: Multiple levels of a resilience process". Development and psychopathology (0954-5794), 19 (3), p. 729.

Degnan, K. A., Hane, A. A., Henderson, H. A., Moas, O. L., Reeb-Sutherland, B. C., & Fox, N. A. (2011). Longitudinal stability of temperamental exuberance and social–emotional outcomes in early childhood. *Developmental Psychology*, *47*(3), 765–780. doi:10.1037/a0021316

Dietrich, A., Riese, H., Sondeijker, F. E. P. L., Greaves-Lord, K., van Roon, A. M., Ormel, J., Neeleman, J., et al. (2007) Externalizing and Internalizing Problems in Relation to Autonomic Function: A Population-Based Study in Preadolescents. *Journal of the American Academy of Child & Adolescent Psychiatry*, *46*(3), 378–386. doi:10.1097/CHI.0b013e31802b91ea

Eisenberg, N., Smith, C. L., & Spinard, T. L. (2011). Effortful control: relations with emotion regulation, adjustment, and socialization in childhood. In Vohs, K. D., and Baumeister, R. F. (Eds). *Handbook of self-regulation* (2nd ed.). (pp. 263-283). New York: The Guilford Press.

Eisenberg, N., Sulik, M. J., Spinrad, T. L., Edwards, A., Eggum, N. D., Liew, J., Sallquist, J., et al. (2011). Differential susceptibility and the early development of aggression: Interactive effects of respiratory sinus arrhythmia and environmental quality. *Developmental Psychology*. doi:10.1037/a0026518

Eisenberg, N., Valiente, C., Spinrad, T. L., Cumberland, A., Liew, J., Reiser, M., Zhou, Q., et al. (2009). Longitudinal relations of children's effortful control, impulsivity, and negative

emotionality to their externalizing, internalizing, and co-occurring behavior problems. *Developmental Psychology*, *45*(4), 988–1008. doi:10.1037/a0016213

El-Sheikh, M. (2001). Parental drinking problems and children's adjustment: Vagal regulation and emotional reactivity as pathways and moderators of risk. *Journal of Abnormal Psychology*, *110*(4), 499–515. doi:10.1037/0021-843X.110.4.499

El-Sheikh, M., Arsiwalla, D. D., Hinnant, J. B., & Erath, S. A. (2011). Children's internalizing symptoms: The role of interactions between cortisol and respiratory sinus arrhythmia. *Physiology & Behavior*, *103*(2), 225–232. doi:10.1016/j.physbeh.2011.02.004

El-Sheikh, M., Harger, J., & Whitson, S. M. (2001). Exposure to Interparental Conflict and Children's Adjustment and Physical Health: The Moderating Role of Vagal Tone. *Child Development*, *72*(6), 1617–1636. doi:10.1111/1467-8624.00369

El-Sheikh, M., & Hinnant, J. B. (2011). Marital conflict, respiratory sinus arrhythmia, and allostatic load: Interrelations and associations with the development of children's externalizing behavior. *Development and psychopathology*, *23*(3), 815–829. doi:10.1017/S0954579411000320

El-Sheikh, M., Hinnant, J. B., & Erath, S. (2011). Developmental trajectories of delinquency symptoms in childhood: The role of marital conflict and autonomic nervous system activity. *Journal of Abnormal Psychology*, *120*(1), 16–32. doi:http://dx.doi.org.ezaccess.libraries.psu.edu/10.1037/a0020626

El-Sheikh, M., & Whitson, S. A. (2006). Longitudinal Relations Between Marital Conflict and Child Adjustment: Vagal Regulation as a Protective Factor. *Journal of Family Psychology*, *20*(1), 30–39. doi:10.1037/0893-3200.20.1.30

El-Sheikh, M. (2005). Stability of respiratory sinus arrhythmia in children and young adolescents: A longitudinal examination. *Developmental Psychobiology*, *46*(1), 66–74. doi:10.1002/dev.20036

Ellis, B. J., Boyce, W. T., Belsky, J., Bakermans-Kranenburg, M. J., & van Ijzendoorn, M. H. (2011). Differential susceptibility to the environment: An evolutionary–neurodevelopmental theory. *Development and Psychopathology*, *23*(01), 7–28. doi:10.1017/S0954579410000611

Fanti, K. A., & Henrich, C. C. (2010). Trajectories of pure and co-occurring internalizing and externalizing problems from age 2 to age 12: Findings from the National Institute of Child Health and Human Development Study of Early Child Care. *Developmental Psychology*, *46*(5), 1159–1175. doi:10.1037/a0020659

Forbes, E. E., Fox, N. A., Cohn, J. F., Galles, S. F., & Kovacs, M. (2006). Children's affect regulation during a disappointment: Psychophysiological responses and relation to parent history of depression. *Biological Psychology*, *71*(3), 264–277. doi:10.1016/j.biopsycho.2005.05.004

Fox, N. A., Henderson, H. A., Rubin, K. H., Calkins, S. D., & Schmidt, L. A. (2001). Continuity and Discontinuity of Behavioral Inhibition and Exuberance: Psychophysiological and Behavioral Influences across the First Four Years of Life. *Child Development*, *72*(1), 1–21. doi:10.1111/1467-8624.00262

Fox, N. A., Henderson, H. A., Marshall, P. J., Nichols, K. E., & Ghera, M. M. (2005). Behavioral Inhibition: Linking Biology and Behavior within a Developmental Framework. *Annual Review of Psychology*, *56*(1), 235–262. doi:10.1146/annurev.psych.55.090902.141532

Friedman, B. H., & Thayer, J. F. (1998). Autonomic balance revisited: Panic anxiety and heart rate variability. *Journal of Psychosomatic Research*, *44*(1), 133–151. doi:10.1016/S0022-3999(97)00202-X

Garcia-Coll, C., Kagan, J., & Reznick, J. S. (1984). Behavioral inhibition in young children. *Child development*, *55*(3), 1005–1019.

Gazelle, H., & Rubin, K. H. (2010). Social anxiety in childhood: Bridging developmental and clinical perspectives. In H. Gazelle & K. H. Rubin (Eds.), Social anxiety in childhood: Bridging developmental and clinical perspectives. New Directions for Child and Adolescent Development, 127, 1–16. San Francisco: Jossey-Bass.

Gentzler, A. L., Santucci, A. K., Kovacs, M., & Fox, N. A. (2009). Respiratory sinus arrhythmia reactivity predicts emotion regulation and depressive symptoms in at-risk and control children. *Biological Psychology*, *82*(2), 156–163. doi:10.1016/j.biopsycho.2009.07.002

Gest, S. D. (1997). Behavioral inhibition: Stability and associations with adaptation from childhood to early adulthood. *Journal of Personality and Social Psychology*, *72*(2), 467–475. doi:10.1037/0022-3514.72.2.467

Goldsmith, H. H. (1996). "Studying Temperament via Construction of the Toddler Behavior Assessment Questionnaire". Child development (0009-3920), 67 (1), p. 218. doi: 10.1111/j.1467-8624.1996.tb01730.x

Goldsmith, H. Hill, Buss, A. H., Plomin, R., Rothbart, M. K., Thomas, A., Chess, S., Hinde, R. A., et al. (1987). Roundtable: What Is Temperament? Four Approaches. *Child Development*, *58*(2), 505. doi:10.1111/1467-8624.ep7253747

Goldsmith, H.H, & Lemery, K. S. (2000). Linking temperamental fearfulness and anxiety symptoms: a behavior–genetic perspective. *Biological Psychiatry*, *48*(12), 1199–1209. doi:10.1016/S0006-3223(00)01003-9

Grossman, P., Beek, J., & Wientjes, C. (1990). A Comparison of Three Quantification Methods for Estimation of Respiratory Sinus Arrhythmia. *Psychophysiology*, *27*(6), 702–714. doi:10.1111/j.1469-8986.1990.tb03198.x

Gunnar, M. R., Tout, K., de Haan, M., Pierce, S., & Stanbury, K. (1997). Temperament, social competence, and adrenocortical activity in preschoolers. *Developmental Psychobiology*, *31*(1), 65–85. doi:10.1002/(SICI)1098-2302(199707)31:1<65::AID-DEV6>3.0.CO;2-S

Graziano, P. A., Keane, S. P., & Calkins, S. D. (2007). Cardiac Vagal Regulation and Early Peer Status. *Child Development*, *78*(1), 264–278. doi:10.1111/j.1467-8624.2007.00996.x

Hastings, P. D., Nuselovici, J. N., Utendale, W. T., Coutya, J., McShane, K. E., & Sullivan, C. (2008). Applying the polyvagal theory to children's emotion regulation: Social context, socialization, and adjustment. *Biological Psychology*, *79*(3), 299–306. doi:10.1016/j.biopsycho.2008.07.005

Hinnant, J. B., & El-Sheikh, M. (2013). Codevelopment of externalizing and internalizing symptoms in middle to late childhood: Sex, baseline respiratory sinus arrhythmia, and respiratory sinus arrhythmia reactivity as predictors. *Development and Psychopathology*, *25*(02), 419–436. doi:10.1017/S0954579412001150

Hinnant, J. B., & El-Sheikh, M. (2009). Children's Externalizing and Internalizing Symptoms over Time: The Role of Individual Differences in Patterns of RSA Responding. *Journal of Abnormal Child Psychology*, *37*(8), 1049–1061. doi:10.1007/s10802-009-9341-1

Hirshfeld, D. R., Rosenbaum, J. F., Biederman, J., Bolduc, E. A., Faraone, S. V., Snidman, N., Reznick, J. S., et al. (1992) Stable Behavioral Inhibition and Its Association with Anxiety Disorder. *Journal of the American Academy of Child & Adolescent Psychiatry*, *31*(1), 103–111. doi:10.1097/00004583-199201000-00016

Kagan, J. & Fox, N. A. (2006) Biology, culture, and temperamental biases. In Eisenberg, N., Damon, W., & Lerner, R. (Eds.). *Handbook of child psychology* (6th ed.), 167-225. New York: J. Wiley.

Kagan, J., Reznick, J. S., Clarke, C., Snidman, N., & Garcia-Coll, C. (1984). Behavioral inhibition to the unfamiliar. *Child Development*, *55*(6), 2212–2225. doi:10.1111/1467-8624.ep7305104

Kagan, J., Reznick, J. S., & Snidman, N. (1987). The Physiology and Psychology of Behavioral Inhibition in Children. *Child Development*, *58*(6), 1459. doi:10.2307/1130685

Kagan, J., & Snidman, N. (1991). Infant predictors of inhibited and uninhibited profiles. *Psychological Science*, *2*(1), 40–44. doi:10.1111/j.1467-9280.1991.tb00094.x

Katz, L. F. (2007). Domestic violence and vagal reactivity to peer provocation. *Biological Psychology*, *74*(2), 154–164. doi:10.1016/j.biopsycho.2005.10.010

Katz, L. F., & Rigterink, T. (in press). Domestic Violence and Socialization. In Dennis, T. A., Buss, K. A., and Hastings, P. D. (Eds.). Physiological measures of emotion from a developmental perspective: state of the science. 80-92.

Klein, D.N., Dyson, M.W., Kujawa, A.J., & Kotov, R. (2012). Temperament and internalizing disorders. In M. Zentner & R. L. Shiner (Eds.), *Handbook of temperament* (pp. 541-561). New York: Guilford.

Lahey, B. B., Rathouz, P. J., Hulle, C. V., Urbano, R. C., Krueger, R. F., Applegate, B., … Waldman, I. D. (2008). Testing Structural Models of DSM-IV Symptoms of Common Forms of Child and Adolescent Psychopathology. *Journal of Abnormal Child Psychology*, *36*(2), 187–206. doi:10.1007/s10802-007-9169-5

Liew, J., Eisenberg, N., Spinrad, T. L., Eggum, N. D., Haugen, R. G., Kupfer, A., Reiser, M. R., et al. (2011). Physiological Regulation and Fearfulness as Predictors of Young Children's Empathy‐related Reactions. *Social Development*, *20*(1), 111–134. doi:10.1111/j.1467-9507.2010.00575.x

Lilienfeld, S. O. (2003). Comorbidity Between and Within Childhood Externalizing and Internalizing Disorders: Reflections and Directions. *Journal of Abnormal Child Psychology*, *31*(3), 285–291. doi:10.1023/A:1023229529866

Lilienfeld, S. O., Waldman, I. D., & Israel, A. C. (1994). A Critical Examination of the Use of the Term and Concept of Comorbidity in Psychopathology Research. *Clinical Psychology: Science and Practice*, *1*(1), 71–83. doi:10.1111/j.1468-2850.1994.tb00007.x

Marmorstein, N. R. (2007). Relationships between anxiety and externalizing disorders in youth: the influences of age and gender. *Journal of Anxiety Disorders*, *21*(3), 420–432. doi:10.1016/j.janxdis.2006.06.004

Marshall, P. J., & Stevenson‐Hinde, J. (1998). Behavioral inhibition, heart period, and respiratory sinus arrhythmia in young children. *Developmental Psychobiology*, *33*(3), 283–292. doi:10.1002/(SICI)1098-2302(199811)33:3<283::AID-DEV8>3.0.CO;2-N

Morales, S., Beekman, C., Davis, E. & Buss, K.A. (2012). Comparison among different models for evaluating RSA reactivity in children. *Psychophysiology (0048-5772)*, 49, p. S80.

Obradović, J., Bush, N. R., & Boyce, W. T. (2011). The Interactive Effect of Marital Conflict and Stress Reactivity on Externalizing and Internalizing Symptoms: The Role of Laboratory Stressors. *Development and Psychopathology*, *23*(01), 101–114. doi:10.1017/S0954579410000672

Obradović, J., Bush, N. R., Stamperdahl, J., Adler, N. E., & Boyce, W. T. (2010). Biological Sensitivity to Context: The Interactive Effects of Stress Reactivity and Family Adversity on Socioemotional Behavior and School Readiness. *Child Development*, *81*(1), 270–289. doi:10.1111/j.1467-8624.2009.01394.x

Pérez-Edgar, K., & Fox, N. A. (2005). Temperament and Anxiety Disorders. *Child and Adolescent Psychiatric Clinics of North America*, *14*(4), 681–706. doi:10.1016/j.chc.2005.05.008

Pfeifer, M., Goldsmith, H. H., Davidson, R. J., & Rickman, M. (2002). Continuity and Change in Inhibited and Uninhibited Children. *Child Development*, *73*(5), 1474–1485. doi:10.1111/1467-8624.00484

Porges, S. W. (2007). The polyvagal perspective. *Biological Psychology*, *74*(2), 116–143. doi:10.1016/j.biopsycho.2006.06.009

Putnam, S. P., & Stifter, C. A. (2005). Behavioral Approach–Inhibition in Toddlers: Prediction From Infancy, Positive and Negative Affective Components, and Relations With Behavior Problems. *Child Development*, *76*(1), 212–226. doi:10.1111/j.1467-8624.2005.00840.x

Rapee, R. M., & Coplan, R. J. (2010). Conceptual relations between anxiety disorder and fearful temperament. In H. Gazelle & K. H. Rubin (Eds.), *Social anxiety in childhood: Bridging developmental and clinical perspectives. New Directions for Child and Adolescent Development*, *127*, 17–31. San Francisco: Jossey-Bass.

Rigterink, T., Fainsilber Katz, L., & Hessler, D. M. (2010). Domestic Violence and Longitudinal Associations With Children's Physiological Regulation Abilities. *Journal of Interpersonal Violence*, *25*(9), 1669–1683. doi:10.1177/0886260509354589

Rothbart, M. K. (2011). *Becoming Who We Are: Temperament and Personality in Development*. Guilford Press.

Rothbart, M. K., & Bates, J. E., (2006) Temperament. In Eisenberg, N., Damon, W., & Lerner, R. *Handbook of child psychology* 6, 99-166. New York: J. Wiley

Rubin, K. H., Coplan, R. J., & Bowker, J. C. (2009). Social Withdrawal in Childhood. *Annual Review of Psychology*, *60*(1), 141–171. doi:10.1146/annurev.psych.60.110707.163642

Schwartz, C. E., Snidman, N., & Kagan, J. (1996). Early childhood temperament as a determinant of externalizing behavior in adolescence. *Development and Psychopathology*, *8*(03), 527–537. doi:10.1017/S0954579400007252

Schwartz, C. E., Snidman, N., & Kagan, J. (1999). Adolescent Social Anxiety as an Outcome of Inhibited Temperament in Childhood. *Journal of the American Academy of Child and Adolescent Psychiatry*, *38*(8), 1008–1015. doi:10.1097/00004583-199908000-00017

Shannon, K. E., Beauchaine, T. P., Brenner, S. L., Neuhaus, E., & Gatzke-Kopp, L. (2007). Familial and Temperamental Predictors of Resilience in Children at Risk for Conduct Disorder and Depression. *Development and Psychopathology*, *19*(03), 701–727. doi:10.1017/S0954579407000351

Semel E., Wiig, E. H., & Secord, W. (1986). The Clinical Evaluation of Language Fundamentals--Revised. New York: The Psychological Corporation.

Shiner, R. L., Buss, K. A., McClowry, S. G., Putnam, S. P., Saudino, K. J., & Zentner, M. (2012). What Is Temperament Now? Assessing Progress in Temperament Research on the Twenty-Fifth Anniversary of Goldsmith et al. (). *Child Development Perspectives*, *6*(4), 436–444. doi:10.1111/j.1750-8606.2012.00254.x

Sterba, S. K., Copeland, W., Egger, H. L., Jane Costello, E., Erkanli, A., & Angold, A. (2010). Longitudinal dimensionality of adolescent psychopathology: testing the differentiation hypothesis. *Journal of Child Psychology and Psychiatry*, *51*(8), 871–884. doi:10.1111/j.1469-7610.2010.02234.x

Stifter, C. A., Putnam, S., & Jahromi, L. (2008). Exuberant and Inhibited Toddlers: Stability of Temperament and Risk for Problem Behavior. *Development and Psychopathology*, *20*(02), 401–421. doi:10.1017/S0954579408000199

Strelau, J. (1998). *Temperament: A Psychological Perspective*. Springer.

Sutton, S. K., & Davidson, R. J. (1997). Prefrontal Brain Asymmetry: A Biological Substrate of the Behavioral Approach and Inhibition Systems. *Psychological Science*, *8*(3), 204–210. doi:10.1111/j.1467-9280.1997.tb00413.x

Tackett, J.L., Martel, M.M., & Kushner, S.C. (2012). Temperament, externalizing disorders, and attention-deficit/hyperactivity disorder. In M. Zentner & R. L. Shiner (Eds.), *Handbook of temperament* (pp. 562-580). New York: Guilford.

Wiesner, M., & Kim, H. K. (2006). Co-occurring delinquency and depressive symptoms of adolescent boys and girls: A dual trajectory modeling approach. *Developmental Psychology*, *42*(6), 1220–1235. doi:10.1037/0012-1649.42.6.1220

Appendix

Figures and Tables

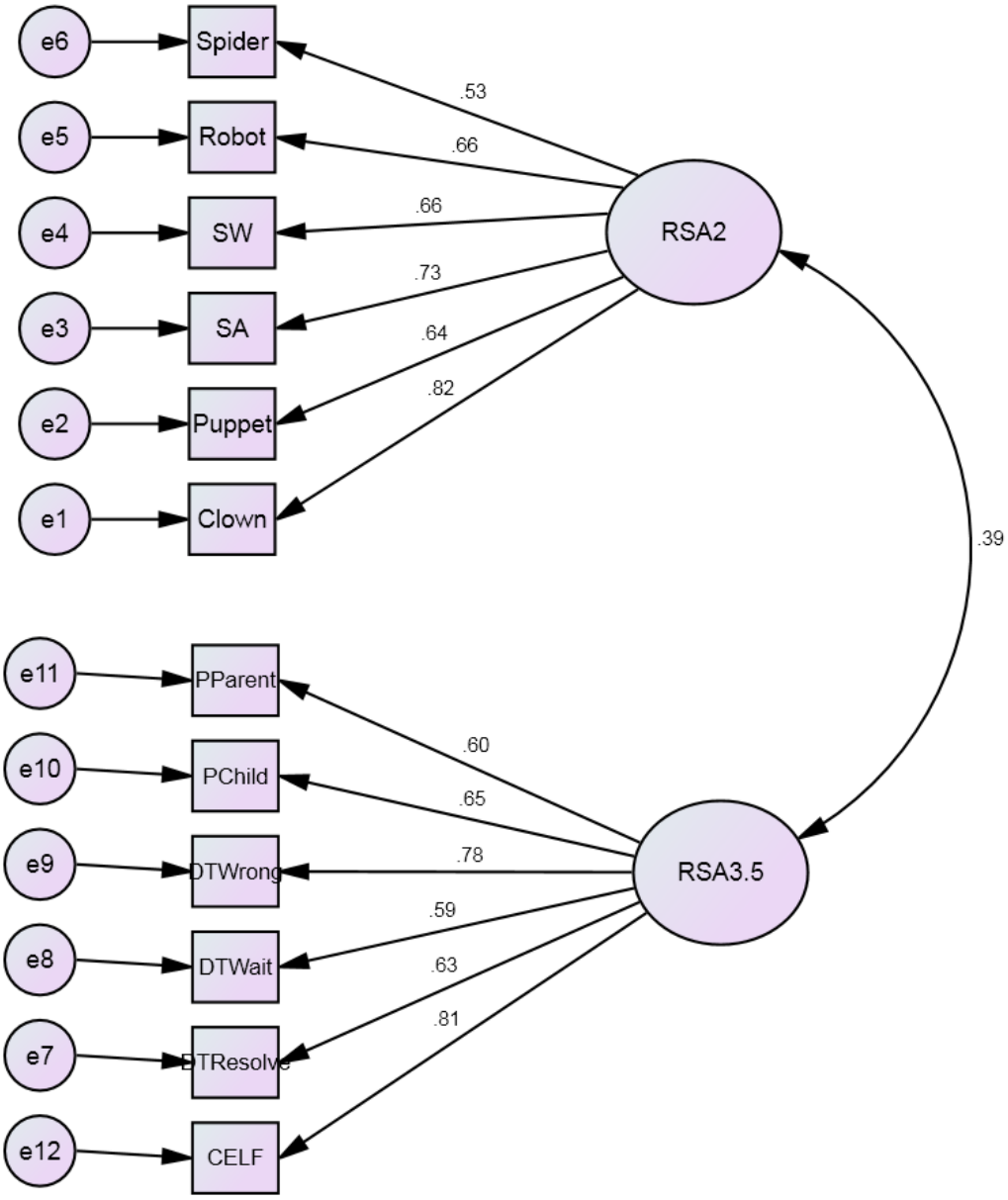
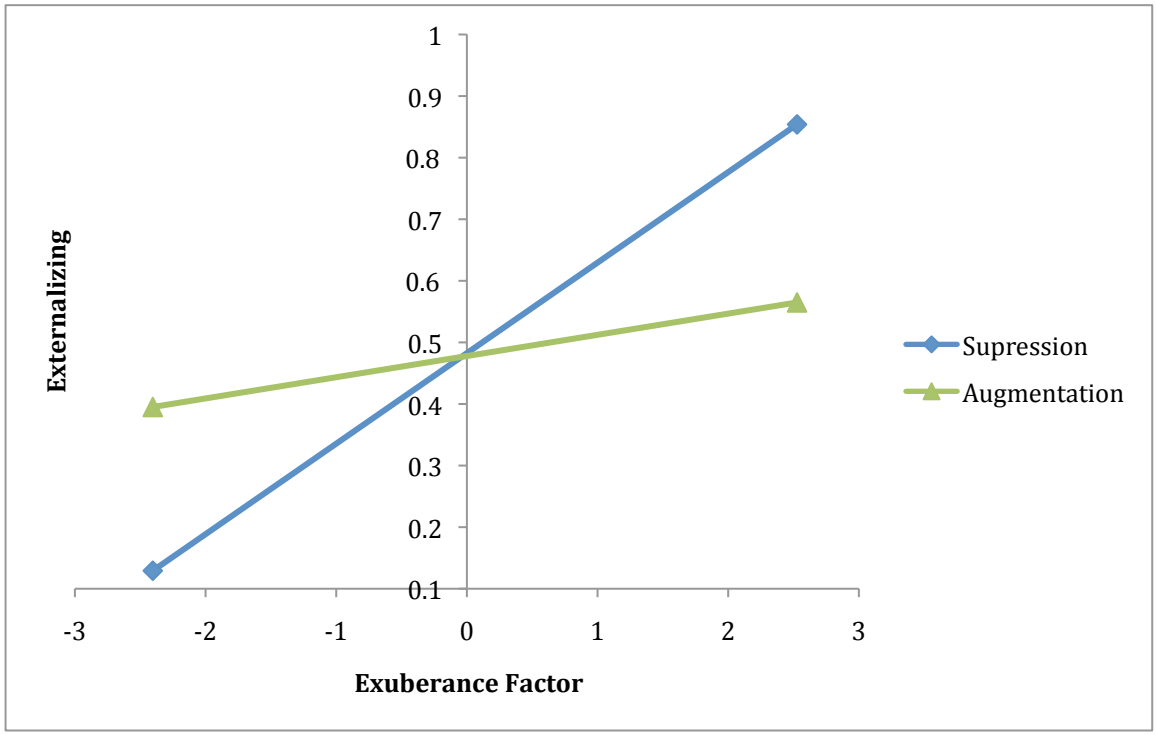


Figure 1. Structural equation model of the latent factor of the six RSA reactivity measures at age 2, the latent factor of the six RSA reactivity measures at age 3.5, and the relation between the two latent factors.
Note: SW=Stranger Working; SA=Stranger Approach; Puppet=Puppet Show; PParent=Pop-up Snakes Parent; PChild=Pop-up Snakes Child; DT=Dissapointment Task; All estimates are standardized.



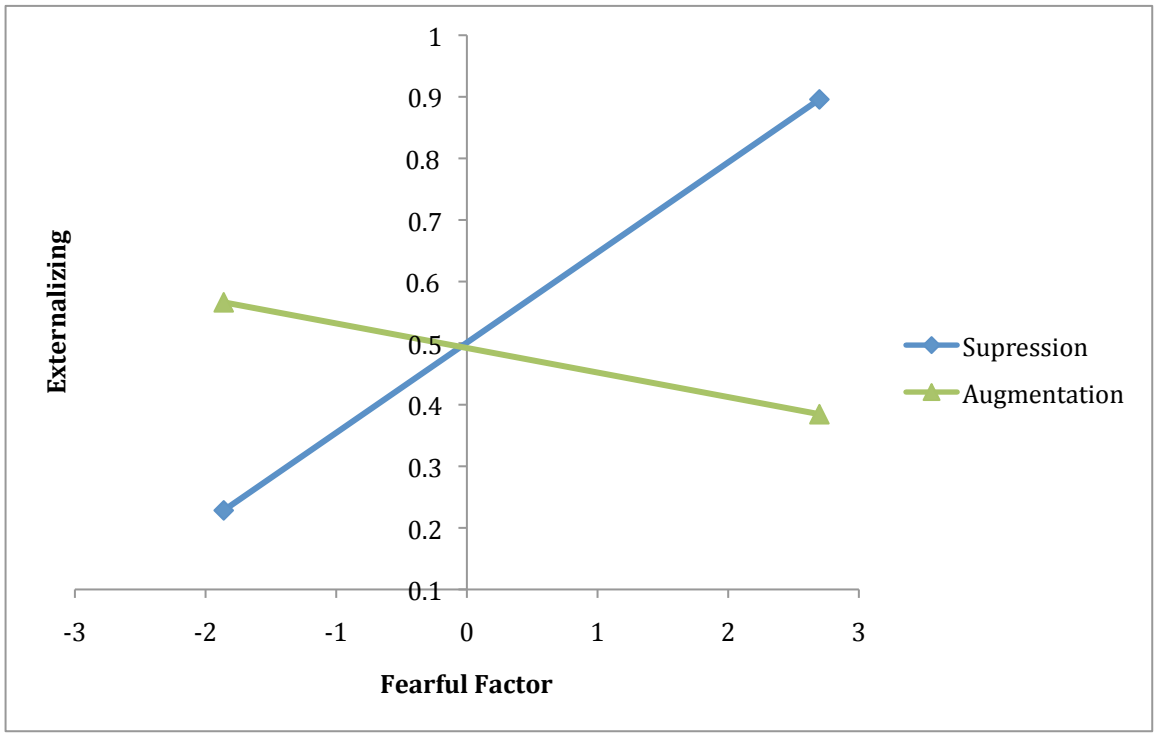


Figure 2. Externalizing symptoms as a function of the exuberant factor (above) and the fearful factor (below) and RSA reactivity at 24-months for girls only. RSA suppression is defined as 1 *SD* below the mean and augmentation as 1 *SD* above the mean.

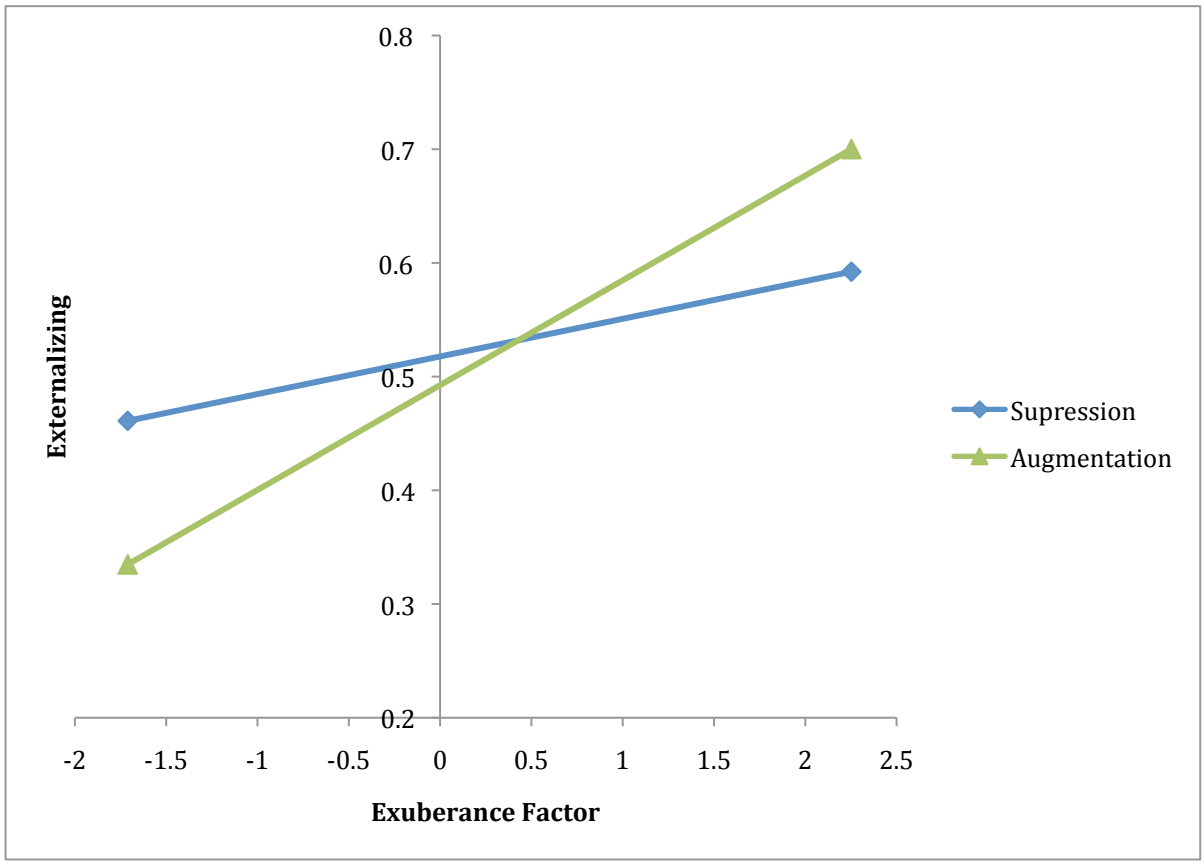
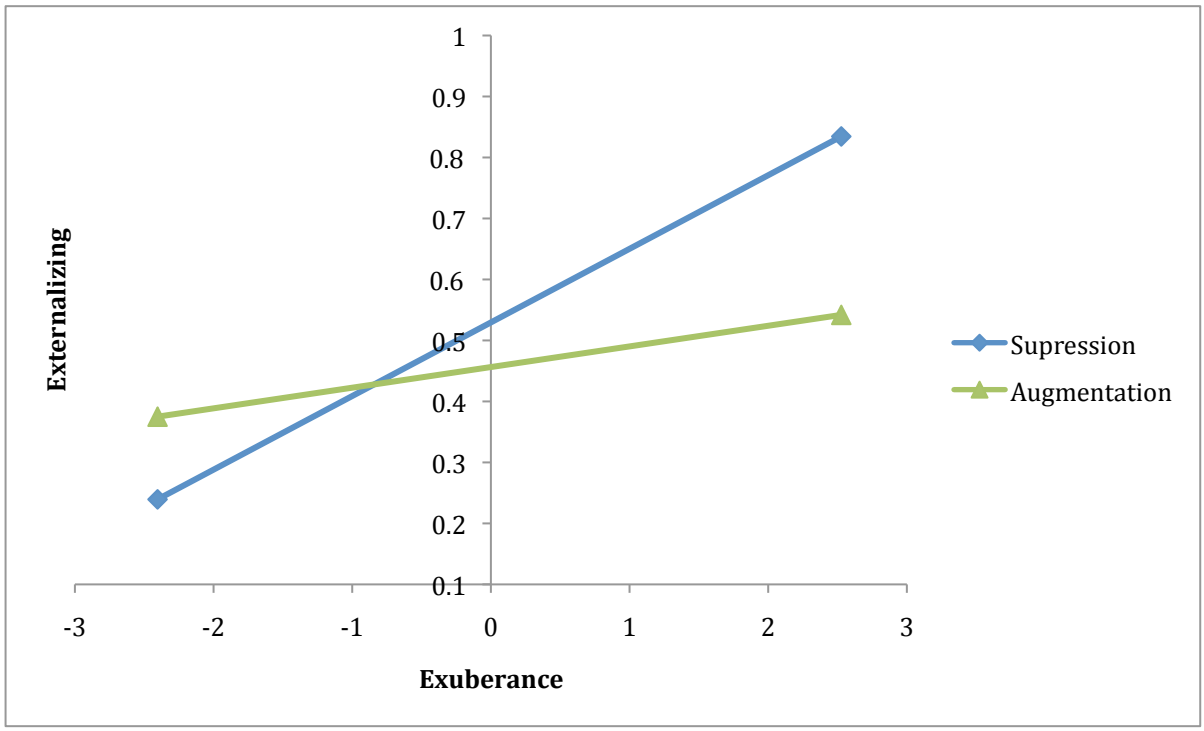


Figure 3. Externalizing symptoms as a function of the exuberant factor and RSA reactivity at 24-months for boys only. RSA suppression is defined as 1 *SD* below the mean and augmentation as 1 *SD* above the mean. Note: This interaction is marginally significant.



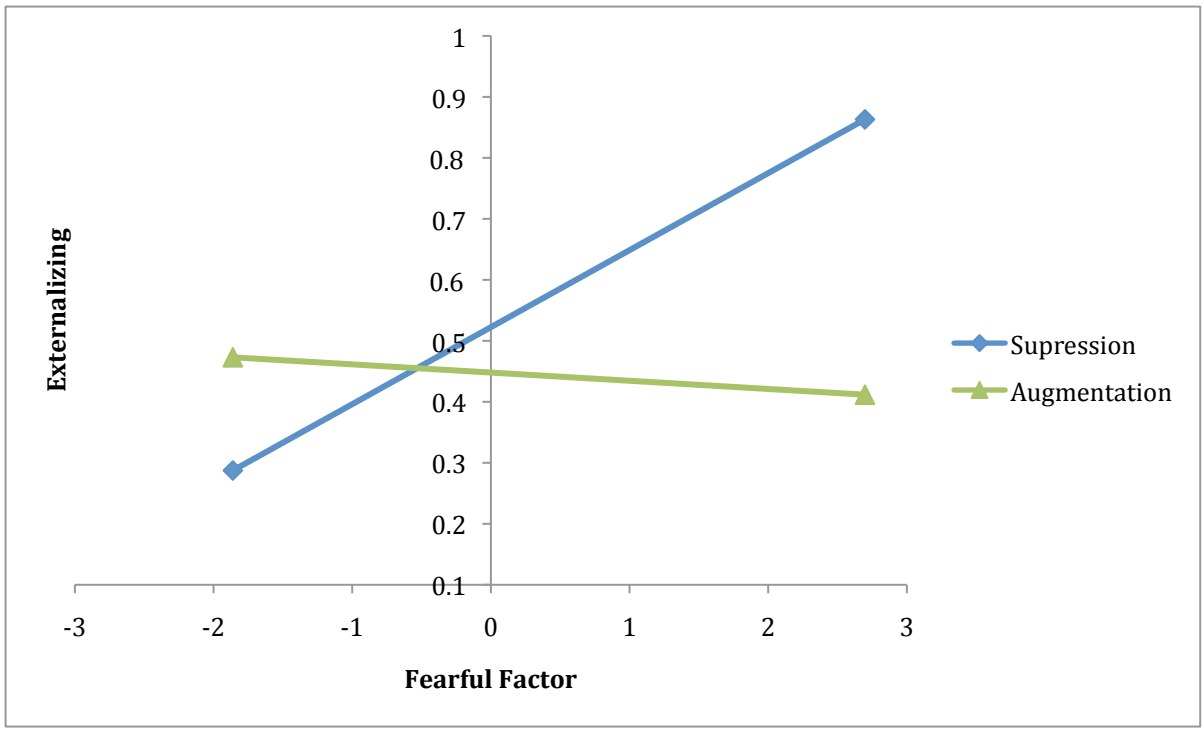


Figure 4. Externalizing symptoms as a function of the exuberant factor (above) and the fearful factor (below) and RSA reactivity at 42-months for girls only. RSA suppression is defined as 1 *SD* below the mean and augmentation as 1 *SD* above the mean.

Table 1.
Factor loadings based on a principle components analysis with varimax rotation for 5 scales from the ITSEA.

Scale	Exuberance	Fear
Activity	**0.85**	0.10
Impulsivity	**0.75**	0.10
Attention	**-0.62**	0.09
Inhibition to Novelty	**-**0.22	**0.82**
Sensory Sensitivity	0.32	**0.71**

Note: Fear= Fearful Temperament. *N*=481

Table 2.

Means, standard deviations, and intercorrelations of the factors scores for exuberance and fearful factors, gender, RSA reactivity at 24- and 42-months, externalizing, and internalizing.

	Variable	Mean	SD	1	2	3	4	5	6
1	Gender	**	**	-					
2	Exuberance	0.05	1.02	-.12	-				
3	Fear	0.00	1.09	.09	-.11	-			
4	RSA 24m	0.00	0.56	.05	-.02	.10	-		
5	RSA 42m	0.00	0.50	.01	**.18***	.01	**.62***	-	
6	Externalizing	0.50	0.19	-.10	**.38***	.01	-.01	.02	-
7	Internalizing	0.43	0.16	-.02	.00	**.18***	0.10	-.06	**.39***

Note: $p < .05$. *SD* = Standard Deviation. **Gender = 78 boys and 76 girls.

Table 3.
Summary of Four Hierarchical Regressions of Gender, Exuberance, Fearful, RSA at 24- and 42-months, and their Interactions on Externalizing and Internalizing used to Test the Main Hypotheses

Model	Variable	*B*	S.E. β	β	*p*
	Externalizing				
	24-month RSA				
1	Gender	-0.024	0.028	-0.063	0.499
	Exuberance	**0.071**	**0.014**	**0.385**	**0.001**
2	Gender	-0.026	0.029	-0.069	0.417
	Exuberance	**0.055**	**0.021**	**0.299**	**0.012**
	RSA	0.038	0.043	0.107	0.645
	Gender X Exuberance	0.027	0.029	0.107	0.357
	Gender X RSA	-0.046	0.057	-0.097	0.662
	Exuberance X RSA	-0.025	0.025	-0.084	0.640
3	Gender	-0.022	0.027	-0.058	0.381
	Exuberance	**0.062**	**0.02**	**0.339**	**0.004**
	RSA	-0.02	0.043	-0.057	0.710
	Gender X Exuberance	0.032	0.027	0.126	0.406
	Gender X RSA	0.015	0.056	0.031	0.951
	Exuberance X RSA	0.047	0.034	0.156	0.191
	Gender X RSA X Exuberance	**-0.159**	**0.048**	**-0.371**	**0.030**
	42-month RSA				
1	Gender	-0.024	0.028	-0.063	0.499
	Exuberance	**0.071**	**0.014**	**0.385**	**0.001**
2	Gender	-0.027	0.029	-0.071	0.438
	Exuberance	**0.052**	**0.021**	**0.281**	**0.013**
	RSA	0.026	0.044	0.058	0.655
	Gender X Exuberance	0.028	0.029	0.111	0.337
	Gender X RSA	-0.107	0.07	-0.151	0.211
	Exuberance X RSA	-0.012	0.032	-0.03	0.949
3	Gender	-0.016	0.028	-0.041	0.603
	Exuberance	**0.058**	**0.021**	**0.315**	**0.010**
	RSA	0.014	0.043	0.032	0.761
	Gender X Exuberance	0.021	0.028	0.08	0.370
	Gender X RSA	-0.116	0.067	-0.163	0.181

	Exuberance X RSA	0.055	0.043	0.132	0.248
	Gender X RSA X Exuberance	-0.184	0.065	-0.308	0.086
	Internalizing				
	24-month RSA				
1	Gender	-0.011	0.026	-0.035	0.639
	Fear	**0.027**	**0.012**	**0.186**	**0.024**
2	Gender	-0.014	0.026	-0.044	0.630
	Fear	0.028	0.017	0.192	0.082
	RSA	-0.052	0.04	-0.174	0.104
	Gender X Fear	-0.002	0.024	-0.01	0.891
	Gender X RSA	0.032	0.053	0.08	0.480
	Fear X RSA	0.029	0.028	0.087	0.263
3	Gender	-0.012	0.027	-0.039	0.693
	Fear	0.029	0.017	0.198	0.073
	RSA	-0.052	0.043	-0.174	0.085
	Gender X Fear	-0.001	0.024	-0.005	0.917
	Gender X RSA	0.036	0.055	0.09	0.396
	Fear X RSA	0.058	0.04	0.174	0.156
	Gender X RSA X Fear	-0.054	0.056	-0.121	0.369
	42-month RSA				
1	Gender	-0.011	0.026	-0.035	0.639
	Fear	**0.027**	**0.012**	**0.186**	**0.024**
2	Gender	-0.015	0.026	-0.047	0.689
	Fear	0.021	0.017	0.147	0.147
	RSA	-0.015	0.041	-0.039	0.507
	Gender X Fear	0.009	0.025	0.043	0.854
	Gender X RSA	-0.008	0.064	-0.014	0.837
	Fear X RSA	-0.039	0.034	-0.099	0.385
3	Gender	-0.011	0.026	-0.035	0.689
	Fear	0.019	0.017	0.129	0.214
	RSA	-0.016	0.041	-0.043	0.522
	Gender X Fear	0.006	0.025	0.027	0.981
	Gender X RSA	-0.012	0.064	-0.019	0.872
	Fear X RSA	-0.076	0.042	-0.192	0.079
	Gender X RSA X Inhibition	0.092	0.072	0.145	0.082

Table 4.
Summary of Four Hierarchical Regressions of Gender, Exuberance, Fearful, RSA at 24- and 42-months, and their Interactions on Externalizing and Internalizing

Model	Variable	*B*	S.E. β	β	*P*
	Externalizing				
	24-month RSA				
1	Gender	-0.024	0.028	-0.063	0.405
	Exuberance	**0.071**	**0.014**	**0.385**	**0.001**
	Fear Factor	0.025	0.013	0.146	0.054
2	Gender	-0.026	0.029	-0.069	0.368
	Exuberance	0.055	0.021	0.299	**0.009**
	Fear Factor	0.006	0.018	0.034	0.747
	RSA	0.038	0.043	0.107	0.382
	Gender X Exuberance	0.027	0.029	0.107	0.343
	Gender X Fear	0.043	0.026	0.173	0.107
	Gender X RSA	-0.046	0.057	-0.097	0.421
	Exuberance X RSA	-0.025	0.025	-0.084	0.312
	Fear X RSA	-0.075	0.03	-0.19	**0.015**
3	Gender	-0.022	0.027	-0.058	0.420
	Exuberance	0.062	0.02	0.339	**0.002**
	Fear	0.008	0.017	0.048	0.636
	RSA	-0.02	0.043	-0.057	0.644
	Gender X Exuberance	0.032	0.027	0.126	0.237
	Gender X Fear	0.052	0.025	0.211	**0.038**
	Gender X RSA	0.015	0.056	0.031	0.787
	Exuberance X RSA	0.047	0.034	0.156	0.178
	Fear X RSA	0.017	0.041	0.042	0.684
	Gender X RSA X Exuberance	**-0.159**	**0.048**	**-0.371**	**0.001**
	Gender X RSA X Fear	**-0.206**	**0.057**	**-0.388**	**0.001**
	42-month RSA				
1	Gender	-0.024	0.028	-0.063	0.405
	Exuberance	0.071	0.014	0.385	**0.001**
	Fear	0.025	0.013	0.146	0.054
2	Gender	-0.027	0.029	-0.071	0.352
	Exuberance	**0.052**	**0.021**	**0.281**	**0.017**
	Fear	0.004	0.019	0.021	0.849

	RSA	0.026	0.044	0.058	0.559
	Gender X Exuberance	0.028	0.029	0.111	0.323
	Gender X Fear	0.044	0.027	0.178	0.107
	Gender X RSA	-0.107	0.07	-0.151	0.127
	Exuberance X RSA	-0.012	0.032	-0.03	0.705
	Fear X RSA	-0.049	0.037	-0.105	0.188
3	Gender	-0.016	0.028	-0.041	0.576
	Exuberance	0.058	0.021	0.315	**0.006**
	Fear	0.011	0.018	0.064	0.544
	RSA	0.014	0.043	0.032	0.741
	Gender X Exuberance	0.021	0.028	0.08	0.460
	Gender X Fear	0.052	0.026	0.211	0.049
	Gender X RSA	-0.116	0.067	-0.163	0.087
	Exuberance X RSA	0.055	0.043	0.132	0.202
	Fear X RSA	0.021	0.044	0.045	0.634
	Gender X RSA X Exuberance	**-0.184**	**0.065**	**-0.308**	**0.005**
	Gender X RSA X Fear	**-0.239**	**0.076**	**-0.32**	**0.002**

Internalizing

<u>24-month RSA</u>

1	Gender	-0.011	0.026	-0.035	0.663
	Exuberance	0.003	0.013	0.02	0.808
	Fear	**0.027**	**0.012**	**0.186**	**0.023**
2	Gender	-0.014	0.026	-0.044	0.600
	Exuberance	-0.006	0.019	-0.039	0.753
	Fear Factor	0.028	0.017	0.192	0.102
	RSA	-0.052	0.04	-0.174	0.192
	Gender X Exuberance	0.019	0.027	0.09	0.467
	Gender X Fear	-0.002	0.024	-0.01	0.928
	Gender X RSA	0.032	0.053	0.08	0.543
	Exuberance X RSA	-0.007	0.023	-0.027	0.765
	Fear X RSA	0.029	0.028	0.087	0.303
3	Gender	-0.012	0.027	-0.039	0.645
	Exuberance	-0.008	0.02	-0.049	0.697
	Fear	0.029	0.017	0.198	0.092
	RSA	-0.052	0.043	-0.174	0.226
	Gender X Exuberance	0.022	0.027	0.1	0.418
	Gender X Fear	-0.001	0.024	-0.005	0.963
	Gender X RSA	0.036	0.055	0.09	0.510
	Exuberance X RSA	-0.014	0.034	-0.055	0.681

	Fear X RSA	0.058	0.04	0.174	0.155
	Gender X RSA X Exuberance	0.007	0.047	0.018	0.889
	Gender X RSA X Fear	-0.054	0.056	-0.121	0.336
	42-month RSA				
1	Gender	-0.011	0.026	-0.035	0.663
	Exuberance	0.003	0.013	0.02	0.808
	Fear	**0.027**	**0.012**	**0.186**	**0.023**
2	Gender	-0.015	0.026	-0.047	0.573
	Exuberance	-0.011	0.02	-0.068	0.589
	Fear	0.021	0.017	0.147	0.216
	RSA	-0.015	0.041	-0.039	0.720
	Gender X Exuberance	0.025	0.026	0.115	0.345
	Gender X Fear	0.009	0.025	0.043	0.720
	Gender X RSA	-0.008	0.064	-0.014	0.896
	Exuberance X RSA	-0.039	0.03	-0.111	0.191
	Fear X RSA	-0.039	0.034	-0.099	0.249
3	Gender	-0.011	0.026	-0.035	0.673
	Exuberance	-0.011	0.02	-0.072	0.569
	Fear	0.019	0.017	0.129	0.281
	RSA	-0.016	0.041	-0.043	0.691
	Gender X Exuberance	0.026	0.026	0.12	0.325
	Gender X Fear	0.006	0.025	0.027	0.824
	Gender X RSA	-0.012	0.064	-0.019	0.856
	Exuberance X RSA	-0.01	0.04	-0.029	0.800
	Fear X RSA	-0.076	0.042	-0.192	0.073
	Gender X RSA X Exuberance	-0.045	0.061	-0.09	0.461
	Gender X RSA X Fear	0.092	0.072	0.145	0.207

Table 5.
Summary of Two Hierarchical Regressions of Exuberance, Fearful, Dummy-Coded RSA Trajectories, and their Interactions on Externalizing and Internalizing

Model	Variable	*B*	S.E. β	β	*p*
	Externalizing				
1	**Exuberance**	**0.072**	**0.014**	**0.393**	**0.001**
	Fear	0.024	0.013	0.141	0.061
2	**Exuberance**	**0.073**	**0.014**	**0.396**	**0.001**
	Fear	0.025	0.013	0.145	0.057
	Augmentation	-0.017	0.031	-0.043	0.599
	S-A	-0.016	0.055	-0.022	0.544
	A-S	-0.029	0.048	-0.049	0.778
3	**Exuberance**	**0.085**	**0.022**	**0.46**	**0.001**
	Fear	**0.08**	**0.021**	**0.466**	**0.001**
	Augmentation	-0.022	0.031	-0.059	0.466
	S-A	-0.03	0.054	-0.042	0.540
	A-S	-0.029	0.047	-0.048	0.584
	Exuberance X Augmentation	-0.003	0.03	-0.012	0.917
	Fear X Augmentation	**-0.081**	**0.029**	**-0.3**	**0.006**
	Exuberance X S-A	-0.102	0.063	-0.129	0.291
	Fear X S-A	**-0.103**	**0.049**	**-0.172**	**0.043**
	Exuberance X A-S	-0.051	0.048	-0.088	0.107
	Fear X A-S	**-0.083**	**0.041**	**-0.177**	**0.036**
	Internalizing				
1	Exuberance	0.004	0.013	0.024	0.767
	Fear	**0.027**	**0.012**	**0.183**	**0.025**
2	Exuberance	0.005	0.013	0.029	0.717
	Fear	**0.028**	**0.012**	**0.191**	**0.019**
	Augmentation	-0.035	0.028	-0.11	0.212
	S-A	-0.07	0.05	-0.118	0.283
	A-S	-0.046	0.043	-0.092	0.162
3	Exuberance	0.022	0.02	0.139	0.290
	Fear	0.033	0.019	0.226	0.083
	Augmentation	-0.036	0.028	-0.111	0.204
	S-A	-0.077	0.049	-0.13	0.179

A-S	-0.058	0.043	-0.114	0.121
Exuberance X Augmentation	-0.02	0.027	-0.09	0.464
Fear X Augmentation	-0.01	0.026	-0.044	0.707
Exuberance X S-A	-0.086	0.057	-0.128	0.440
Fear X S-A	-0.089	0.045	-0.175	0.147
Exuberance X A-S	-0.034	0.044	-0.069	0.138
Fear X A-S	**0.054**	**0.037**	**0.136**	**0.048**

Note: The trajectory groups were dummy coded with the suppression group (suppression at both time points) as the reference group. S-A = Suppression at 24-m and augmentation at 42-m. A-S = Augmentation at 24-m and suppression at 42-m. Augmentation = Augmentation at both time points.

Table 6.

Means, standard deviations, and correlations of the factors scores for exuberance and fearful factors with externalizing, and internalizing according to RSA trajectory group.

	Variable	*N*	Means	*SD*	Externalizing	Internalizing
Suppression	Exuberance	63	0.51	0.21	**0.36***	0.11
	Fear	63	0.46	0.16	**0.37***	0.20
Augmentation	Exuberance	62	0.51	0.19	**0.48***	-0.03
	Fear	62	0.42	0.15	-0.12	0.17
Suppress-Augment	Exuberance	17	0.49	0.14	0.24	0.01
	Fear	17	0.42	0.17	0.01	**0.63***
Augment-Suppress	Exuberance	12	0.49	0.19	-0.13	-0.42
	Fear	12	0.39	0.15	-0.2	-0.47

Note: * $p < .05$. *SD* = Standard Deviation. Mean difference in externalizing or internalizing between groups is not significant.