PREDICTING CHILDHOOD EXTERNALIZING DISORDERS IN AT-RISK YOUTH: AN ANALYSIS OF THE AUTONOMIC NERVOUS SYSTEM, TEMPERAMENT, AND PARENTING

by

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ABSTRACT

The aim of the current study was to clarify the pathways by which externalizing behavior can be predicted in preadolescents at risk for aggression. This study examined how parental involvement, autonomic reactivity, and the temperament traits of effortful control and negative affect related among themselves when predicting externalizing behavior as reported by parents and teachers. Although the literature has found associations for each of these variables to behavior individually, no study to date has examined how these variables interact with each other simultaneously when predicting behavior in a sample of at-risk preadolescents. Given past research, it was hypothesized that negative affect would have an indirect relationship to externalizing behavior through autonomic regulation and parental involvement. Effortful control was also thought to moderate the relationship between autonomic reactivity and behavior. Lastly, it was predicted that autonomic reactivity would be associated with parental involvement.

A sample of 360 preadolescents was used to test the model noted above using structural equation modeling procedures. This sample was largely male, African American, and of low-middle socioeconomic status. The results of the models varied by the reporter. With teacher report, behavior was not predicted, but significant relationships among autonomic reactivity, parental involvement, and negative affect were found. With parent report, negative affect predicted externalizing behavior indirectly through parental involvement. Autonomic reactivity and effortful control were also predicted externalizing behavior. Significant gender differences were also found using parent-report of behavior. The differences in findings by reporter and the implications for the prevention and treatment of externalizing behavior are discussed.

DEDICATION

This dissertation is dedicated to all those individuals who have stood by me throughout my time in graduate school. In particular, I wish to thank my wife, Melissa Jiménez. Your unconditional love and emotional support has allowed me to push through this difficult process when it seemed unending. I love you.

LIST OF ABBREVIATIONS AND SYMBOLS

a Cronbach's index of internal consistency

df Degrees of freedom: Number of values free to vary after certain restrictions have been placed on the data.

p Probability associated with the occurrence under the null hypothesis of a value as extreme as or more extreme than the observed value.

SE Standard Error: A measure of how spread out data values are around the mean, defined as the square root of the variance.

z Computed value of a *z* test.

β Standardized regression coefficient

< Less than

> Greater than

= Equal to

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INTRODUCTION

Aggression and conduct problems tend to decrease after early childhood, but some children continue to exhibit externalizing behaviors throughout their development (Campbell, Spieker, Burchinal, & Poe, 2006). It is important to address these children “at-risk” for persistent externalizing behavior given that aggression and conduct problems have been identified as risk factors for future peer rejection, depressive symptoms, substance abuse, and delinquency (for a meta-analysis see Card & Little, 2006). Pathways and physiological markers that may be responsible for the development of persistent externalizing behavior must be examined in order to identify children who may be at most risk for the aforementioned negative life outcomes. Consistent with a contextual social-cognitive model for aggression (Lochman & Wells, 2004), studies that examine the predictive pathways of externalizing behaviors have identified temperament (Frick et al, 2003; Penney and Moretti, 2010; Willowski, Robinson, & Troop-Gordon, 2010), autonomic nervous system (ANS) physiological markers (Boyce et al, 2001; Bubier & Drabick, 2008; Muñoz & Anastassiou-Hadjiucharalambous, 2011), and parenting (Degnan, Calkins, Keane, & Hill-Soderlund, 2008; Ramsden & Hubbard, 2002) as risk factors.

This study examines aspects of each of these constructs when predicting externalizing behavior. To date, there is no research describing the relationships among these variables when predicting problem behaviors in preadolescent samples of children at risk for aggression. Further, the literature relating ANS markers to externalizing behaviors and the conceptual framework behind such relationships is unclear. The current study adds clarity to these gaps in the literature in hopes that this study’s findings may aid in the prevention and treatment of externalizing disorders. Notably, this study will assess the influence of negative affect and effortful control temperamental traits, respiratory sinus arrhythmia (RSA) and skin conductance parasympathetic and sympathetic autonomic reactivity, and positive parental involvement when predicting externalizing behavior. The proposed variables are hypothesized to predict behavior as depicted in Figure 1. To understand the rationale behind the proposed relationships in the model, a review of each of the constructs is warranted. The impact of temperament on behavior will first be discussed followed by an examination of how child regulative abilities influence behavior. The importance of parental involvement in relation to behavior will then be addressed. The conclusion of this section will provide this study's aims and hypotheses.

Temperament

Temperament is a construct that has no universal definition. There is no general agreement on what makes up temperaments, but there are some general characteristics on which there is a consensus. For a history of the development of different temperament theories, refer to Rothbart & Goldsmith (1985), Goldsmith, Buss, Plomin, and Rothbart (1987), and Goldsmith and Campos (1980). Modern temperament theories stem from the work of Thomas and Chess (1977).

Thomas and Chess (1977) conceptualized temperament as a psychological attribute that interacts with other attributes (such as cognition and arousal) in an influential and sequential way. Thomas and Chess's work was novel because it distinguished temperament from personality, but indicated that an individual's context/environment mediated the expression of temperament. Thomas and Chess explained that the relationship of temperamental expression and context was also bidirectional (Goldsmith, et al, 1987). To support their theory, Thomas and Chess interviewed parents asking them to describe their infant's temperament. From a content-analysis of these parental interviews, Thomas and Chess derived nine temperamental dimensions: activity level, approach-withdrawal, mood, attention span-persistence, intensity, distractibility, adaptability, threshold, and rhythmicity (Thomas & Chess, 1963). From these nine dimensions, Thomas and Chess consolidated temperament into three major clusters for classifying temperament: easy, difficult, and slow-to-warm-up (Goldsmith, et al, 1987).

Thomas and Chess's theory and its specific dimensions of temperament sparked a debate among researchers in the late 70s and early 80s as to the true makeup of temperament (Goldsmith & Campos 1980; Goldsmith, et al, 1987). The resulting theories and discussion from these debates helped develop Rothbart and colleagues' theory of temperament; which is arguably the most comprehensive and influential temperamental theory to date.

Rothbart and colleagues initially wanted to determine whether the dimensions derived by Thomas and Chess were accurate. Thus, Rothbart and colleagues conducted their own studies examining their dimensions. Through the use of factor-analytical methods, Rothbart and colleagues demonstrated that Thomas and Chess's (1966) dimensions were not well supported statistically (Rothbart & Bates, 1998). However, item-level factor analyses did yield five dimensions: activity level, positive affect & approach, fear, frustration/irritability, and attentional persistence (Rothbart & Mauro, 1990). From these analyses, Rothbart and colleagues constructed several questionnaires to determine the specific factors that influence temperament at different developmental stages (Rothbart & Derryberry, 1981). For the purposes of this paper, focus will be directed on the conceptualization of child temperament.

Through administration and factor-analysis of their self-developed Child Behavior Questionnaire (CBQ), whose construction was based on the aforementioned temperamental theoretical research, Rothbart and colleagues (1981) determined that there were three primary factors consisting of a total of 11 dimensions that defined temperament. The first of these factors, *surgency/extraversion,* consists of the positive emotionality and approach dimensions. The second factor, *negative affect*, involves discomfort, fear, anger/frustration, and sadness dimensions with supplemental influences from the shyness dimension and negative loadings for soothability and reactivity. The last factor, *effortful control*, is primarily derived from inhibitory control, attentional focusing, low intensity pressure, and perceptual sensitivity. Rothbart and colleagues (1981) also theorized that some of the dimensions that make up these factors were shaped by interactions with the environment. For example, they stated that early in development, these temperamental factors resulted from an interaction between individual characteristics and contributions from the caregiver-child relationship (Rothbart, et al, 1981). Additionally, these factors and their respective dimensions illustrate how Rothbart and colleagues have been able to empirically demonstrate through the rigorous testing of their questionnaires that temperament may result from a combination of several of the characteristics posited by previous researchers. Their theory and respective dimensions emphasize emotional factors (as proposed by Goldsmith & Campos, 1980), behavioral factors (Gray, 1970), and contextual interaction (Thomas & Chess, 1977). Given its comprehensiveness, slight modifications to this theory have provided current research with its widely accepted, although still debatable, conceptualization of child temperament.

Rothbart's theory appears to encapsulate several themes that previous temperament theories shared. In general, what most of these temperamental theories agreed upon is the following. First, most of these theories viewed temperament as a pattern of behavior across time and contexts (Rothbart & Goldsmith, 1985). Second, temperamental dimensions reflect behavioral tendencies rather than the mappings of discrete behavioral acts (Goldsmith, et al, 1987). Third, most of these theorists agree that temperament has biological underpinnings and that temperament becomes more complex as a child matures (Goldsmith, et al, 1987). Lastly, to some degree, expression of temperamental traits appears to be modifiable (Goldsmith, et al, 1987). Where theorists and researchers disagree is in the semantics of the temperament construct; namely, temperament's behavior style, relation to emotional behavior, stability, inheritance, and specific dimensions (Goldsmith, et al, 1987).

For the purposes of this study, Rothbart's current conceptualization of temperament will be adopted as it appears to be the most comprehensive, and has been extensively researched and supported during the last 20 years (Ahadi, Rothbart, & Ye, 1993; Putnam, Ellis, & Rothbart, 2001; Rothbart & Bates, 1998; Rothbart & Derryberry, 1981; Rothbart, Ellis, & Posner, 2004; Rothbart & Mauro, 1990; Rothbart & Rueda, 2005). Rothbart's current conceptualization of temperament defines it as "individual differences in reactivity and self-regulation that are assumed to have a constitutional basis" (Rothbart & Derryberry, 1981). In this definition, reactivity refers to motor, emotional, or attentional responses to internal and external stimuli whereas self-regulation refers to an individual's neural and behavioral processes that function to modulate the individual's underlying reactivity (Rothbart & Derryberry, 1981). The term "constitutional" refers to the enduring biological makeup of the individual that is influenced over time by the individual's heredity/genes, maturation, his/her environment, and his/her experience. In addition to this inclusive, yet specific definition, Rothbart and colleagues have indicated that temperament is a trait that is stable across several, but not all situations (Rothbart & Ahadi, 1994). Further, a child's temperament is believed to be critical in the development of adaptations. Rothbart and Ahadi (1994) suggest that adaptations such as coping styles develop from the interaction between a child's temperament and his/her individual experiences. To comprehend how this particular conceptualization of temperament impacts externalizing behavior, one must analyze its underlying systems from a developmental perspective.

Rothbart and colleagues believe that the underlying systems of temperament are not static, but rather develop themselves over time (Derryberry & Rothbart, 1997; Rothbart, Derryberry, & Hershey, 2000). Early in life, a child's behavior is thought to be primarily reactive to immediate stimuli, but as the child matures, it is thought that more self-regulatory systems develop to modulate the child's reactivity (Rothbart & Rueda, 2005). This developmental perspective of temperament is supported by the work of researchers. Some research suggests that typical children learn to regulate their temperamental characteristics in a manner that is contextually appropriate without adult help between the ages of three and four (Carlson, 2005; Cole, 1986, Cole, Dennis, Smith-Simon, & Cohen, 2009; Wellman et al, 2001). By elementary school, typical children become more sophisticated in the regulation of their temperamental characteristics and can use both emotion and problem-focused strategies to cope with negative situations (Dennis & Keleman, 2009). However, children who fail to develop appropriate regulatory systems tend to be more behaviorally maladjusted (Dennis, Cole, Wiggins, Cohen, & Zalewski, 2009; Eisenberg, et al 2001; Gilliom et al 2002).

Rothbart supports this maturational viewpoint when analyzing the major factors of her temperament theory. Through a series of studies analyzing children at different developmental levels and from different cultures, Rothbart and colleagues demonstrated that the extraversion/surgency and negative affect factors appear to be evident in all cultures since infancy (Rothbart and Rueda, 2005). However, the effortful control factor appears to functionally manifest itself only after a child has matured beyond infancy (Rothbart & Rueda, 2005). Given the research supporting all three factors for the current conceptualization of temperament, the use of only two of these three factors for the current study is put into question. To adequately address why only two factors are used, one must carefully examine each of these factors and the research associated with them. One must also take into consideration the developmental level of the preadolescent sample that is used in the current study.

Effortful Control

Effortful control is conceptualized in the literature as a cognitive control system executed through the executive functioning system (Wilkowski, Robinson, & Troop-Gordon, 2010). Through the executive functioning system, effortful control allows an individual conscious control of the thoughts and actions needed for future-oriented or purposeful behavior (Carlson & Wang, 2007; Zelazo, et al, 1997). Effortful control is also thought to inhibit and control automatic cognitive processes including automatic thoughts or behaviors (Carlson & Wang, 2007; Casey et al, 2002). With regard to externalizing behavior, this control is thought to distract an individual from hostile thoughts, reappraise provocations, forgive such provocations, and suppress possible aggressive impulses (Wilkowski & Robinson, 2008; Wilkowski et al, 2010). In fact, several studies have implicated effortful control when predicting externalizing behavior. Research in populations ranging from pre-K children to college-aged samples has shown that deficits in effortful control have been associated with aggression, conduct problems, and psychopathic traits (Carlson &Wang, 2007; Dennis, Hong, & Solomon, 2010; Liew et al, 2004; Santucci et al, 2008; Sellbom & Verona, 2007; Wilkowski et al, 2010).

Effortful control is deemed necessary for this study because some research suggests that it may be unique in comparison to Rothbart’s other two factors. According to Rothbart and Rueda (2005), effortful control is distinct from the other two factors in that it is not at the “mercy” of positive or negative emotions, but can flexibly approach problematic situations and inhibit responses to a degree. Of note, effortful control is not perfect. Inhibition is not guaranteed as it depends on the strength of the emotion process against which effort is exerted (Rothbart, Derryberry, & Hershey, 2000; Rothbary & Rueda, 2005).

As mentioned previously, effortful control is a not believed to be functionally developed until an individual has matured beyond infancy unlike other temperamental traits (Rothbart & Rueda, 2005). Given that the current study deals with a preadolescent population, if one is to examine temperament, the inclusion of effortful control is important. Effortful control has also been negatively linked with negative affect within a U.S. children’s sample (Ahadi, Rothbart, & Ye, 1993; Rothbart, Ellis, & Posner, 2004). Other research has suggested that effortful control actually moderates the relationship between negative affect and poor social outcomes or externalizing behaviors whereby higher effortful control serves as a buffer against the influence of negative affect (Carlson & Wang, 2007; Liew et al, 2004; Pardini, Lochman, & Wells, 2004). Given that this study intends to examine child temperamental traits, analysis of effortful control is essential given its relative uniqueness, its later development, its implication in externalizing behavior, and its link to the other temperamental factor being studied.

Negative Affect

Negative affect, is conceptualized according to Rothbart’s model by the degree that a child expresses fear, anger/frustration, and sadness (Rothbart, Derryberry, & Hershey, 2000). Given that these traits can be predicted in childhood and at later developmental stages from infant questionnaires, Rothbart and colleagues argue that negative affect is a stable trait developed early in life (Rothbart, et al, 2000). This assumption implies that negative affect may be a temperamental factor that should be relatively stable by preadolescence. As such, to understand how temperament impacts externalizing behavior, negative affect must also be examined.

When conceptualizing negative affect as construct, some of the literature suggests that its underlying mechanisms may vary by context and/or behavior. According to some research, frustration and anger are positively associated to internalizing and externalizing behaviors whereas fear has been shown to positively relate to internalizing behavior, but negatively to externalizing behaviors (Rothbart, et al, 2000). However, Rothbart and colleagues (2000) have also demonstrated that fear tends to decrease significantly after age seven whereas the intensity and duration of frustration/anger tends to increase. Therefore, this research suggests that by the time children reach early adolescence, their negative affect may be more likely influenced by frustration/anger rather than fear. Despite the semantics in negative affect, when negative affect has been researched as a construct, its relationship to externalizing behavior is clear. Negative affect has been linked with aggression, conduct problems, and psychopathy in children (Frick et al, 2003; Hare, 2003; Penney & Moretti, 2010). Children labeled as "at-risk" by a caretaker also tend to be more susceptible to increased levels of negative affect (deCastro, et al, 2005). When broken down by age, associations between negative affect and some form of externalizing behavior have been found across early to late childhood (Bowie, 2010; Spritz et al, 2010; Sullivan, Helms, Kliewer, & Goodman, 2010) and adolescence (Penney & Moretti, 2010). Further, there is some evidence that negative affect may interact with effortful control in ways other than those that have already been noted.

Research linking effortful control to negative affect suggests that effortful control may not make a contribution to externalizing behavior directly, but rather regulate it by controlling the reactive tendencies underlying negative affect (Posner & Rothbart, 2000). Therefore, effortful control may modulate the detrimental aspects of negative affect indirectly in its reduction of externalizing behavior. Negative affect's relative stability, impact on externalizing behavior, and strong link to effortful control deem it necessary for inclusion in the current study if one is to accurately examine the mechanisms by which temperamental factors operate to impact externalizing behavior. Unfortunately, the same cannot be said for extraversion/surgency.

Extraversion/Surgency

Extraversion/surgency is a factor that is conceptualized to develop relatively early through the interaction of genetic influences and a child’s environment (e.g. parent-child relationship; Rothbart & Derryberry, 1981). This factor is typically characterized by a child’s activity, level of smiling/laughter, pleasure expression, impulsivity, shyness, and positive anticipation (Rothbart & Rueda, 2005). Although this factor has shown links to behavior during infancy, these associations become less prominent with the development of effortful control and the relative stability of negative affect (Rothbart & Rueda, 2005). Further, its relationship to the other two factors is less defined with a preadolescent American population. In their study examining Chinese and American child and adult samples, Ahadi and colleagues (1993) found a significant negative association between negative affect and effortful control within the American sample, but no relation between extraversion/surgency and effortful control. There was also no relation found between extraversion/surgency and negative affect. Additionally, whereas negative affect and effortful control have been linked with neurocognitive deficits, no evidence for such a link has been found for extraversion/surgency (Healey, Brodzinsky, Bernstein, Rabinovitz, & Halperin, 2010). Specifically, deficits in the cingulate, dorsolateral prefrontal cortex, ventromedial prefrontal cortex, and the amygdala have been associated with negative affect and effortful control (Blair, 2010; Hare, Comere, & Ranger, 2009; Harenski & Kiehl, 2010; Phillips, Ladouceur, & Drevets, 2008). Some of these neurological areas are also associated with the autonomic nervous system (ANS); another construct under examination in the current study.

With regard to extraversion/surgency's relation to behavior, research suggests that it may not relate to aggression as strongly as does negative affect and effortful control with a preadolescent sample. Although Berdan, Keane, and Calkins (2008) demonstrated that within a pre-K sample, children higher on the extraversion/surgency factor exhibited higher levels of hyperactivity and aggression, recent research suggests that as a child matures, it is his or her development of the effortful control factor that more strongly relates to whether he or she will engage in aggressive behavior (Rothbart & Rueda, 2005). Also, no evidence was found that consistently links extraversion/surgency and externalizing behaviors to older samples of children and adults to the same degree as negative affect and effortful control. Given extraversion/surgency's diminished impact on functioning and behavior by preadolescence and its lack of association to the other two temperamental factors within American child and adult samples, it was excluded in the current study.

Emotion Regulation

Throughout the literature, emotions are implicated in the appropriate management of behavior. According to Frijda (1988), emotions are conceptualized as an individual's perception of his or her personally relevant interplay with the environment, and his or her ability to cope with environmental challenges. Contemporary researchers have refined earlier definitions of emotion like Frijda's (1988) when conceptualizing the regulatory processes of emotion used to modify behavior. According to the social information processing model, an individual's emotion regulation is shaped by behavioral responses to social situations. More specifically, environmental socializers, biological predisposition (temperament), and situational instigators (provocations) all interact in the development of a particular emotion regulation style (deCastro, Koops, Veerman, & Bosch, 2004; Crick & Dodge, 1994; Musher-Eizenman et al, 2004). In other words, appropriate development of emotion regulation is influenced by biological predisposition (temperament) and socioecological contexts (Bush, Lengua, & Colder, 2010; Raver, 2004; Sullivan, Helms, Kliewer, & Goodman, 2010).

With regard to emotional regulation development, some research has indicated that children are able to use appropriate emotion regulation strategies by the time they reach elementary school to cope with negative situations or emotions (Dennis & Keleman, 2009). Other research indicates that children may develop metacognitive (albeit rudimentary) coping strategies as early as three years of age (Davis, Levine, & Lench, 2010; Lagaltuta et al, 1997). However, not all children develop healthy emotion regulation strategies. According to the literature, deficits in emotional regulation have led to several impairments. Rubin and colleagues (1995) found that children who were poor emotion regulators were more behaviorally anxious, reticent, and prone to internalizing problems. Other researchers echoed Rubin's findings by associating the inability to self-regulate in children with anxiety and depression (Bowie, 2010; Eisenberg et al, 2001; Silk, Beinberg, & Morris, 2003). As for the focus of this paper, deficits in emotional regulation have also been linked with externalizing problems. DeCastro and colleagues (2005) found that aggressive 7-13 year-old boys reported less adaptive emotion regulation strategies than non-aggressive boys. Sullivan and colleagues (2010) found that poor regulation of sadness and anger led to higher aggression in fifth through eighth graders. Hill and colleagues (2006) found that children with poorer emotional regulation were characteristic of a chronic-clinical profile comprised by clinically significant externalizing problems when following these children from ages two to five. Bowie (2010) also found that in girls, poor emotional regulation predicted aggression in five through eleven year-olds. In Vasilev and colleagues' (2009) study, they found that higher internalizing and externalizing behaviors were correlated with both self-reported and parent-reported difficulties in self-regulation in both normal and clinical samples of adolescents (Vasilev, et al, 2009).

Although the aforementioned studies support the link between emotional regulation and functioning, the methods by which emotion regulation is measured vary widely across studies. These methods include experimenter observation, parent observation, self-report, and parent report among others. Having such varied and subjective methods make it difficult to ascertain whether it is truly emotional regulation that is predictive of problematic behavior. This research also questions the mechanisms by which emotional regulation is exhibited. Are there more accurate ways of assessing emotional regulation without having to rely on subjective observation or questionnaire methods? The psychophysiological reactivity research of the past 25 years suggests that physiological markers may be one avenue by which emotional regulation could be accurately assessed.

Physiological Emotion Regulation

Two prominent biological systems proposed to be responsible for the regulation of emotion are the autonomic nervous system and hypothalamic-pituitary-adrenocortical (HPA) axis. Although the HPA axis is considered a marker for stress reactivity and has been linked to behavior problems, some research suggests that it is due to autonomic modulation (De Herdt et al, 2009; McBurnett, et al, 1991). Given that the current study employs autonomic markers to measure physiological regulation, examination of the physiological regulation construct will center on the autonomic nervous system.

According to Timberlake (1994) behavioral responses/sequences like those posited by the social information processing model can be organized into "behavioral systems". Thayer and Lane (2000) elaborate on Timberlake's behavioral systems concept by proposing a dynamical systems perspective. Under this perspective, an organism is conceptualized as a complex set of subsystems working in coordinating fashion. These systems are theorized to work through emotions whereby a specific emotion elicits specific action tendencies. In a healthy organism, the biological processes responsible for proper coordination of these systems provide flexible adaptations to meet changing environmental demands (Thayer & Lane, 2000). In essence, Thayer & Lane (2000) posit that emotional regulation is tied to an overall physiological response system. Other researchers support Thayer & Lane's perspective suggesting that there are indeed biological mechanisms underlying the emotional regulation of behaviors (Moffit et al, 2001; Ortiz & Raine, 2004). To visualize the major brain structures that will be referenced when discussing the physiological regulation of emotion, please refer to Figures 2 and 3.

Thayer & Lane (2000) specify their perspective by suggesting that emotional regulation consists of selective attention and appropriate inhibition of affective responses which are tied to autonomic nervous system functioning (Porges, 1991, 1992; Thayer, et al, 2000). The overarching physiological system that Thayer & Lane (2000) claim is responsible for such regulation is the central autonomic network (CAN). The CAN functions by way of brain processes responsible for the regulation of visceromotor, neuroendocrine, and behavioral responses critical to goal-directed behavior and adaptability (Benarroch, 1993). The specific neural structures implicated in the enactment of behavioral processes under this system are hypothesized to include the anterior cingulate, insula, ventromedial prefrontal cortices, amygdala, hypothalamus, periaqueductal gray matter, parabrachial nucleus, nucleus of solitary tract (NST), nucleus ambiguss, and the medulla. The primary output of the CAN is thought to be mediated through ganglionic sympathetic and parasympathetic neurons. These neurons, in turn, innervate the heart via the stellate ganglia and the vagus nerve (Thayer & Lane, 2000). Due to the vagus nerve's influence on the heart and the heart's influence on behavior, the CAN is posited to be under inhibitory tonic control, which is thought to be achieved through GABA interneurons with the NST. As a result of this theorized pathway, disruption of the GABA neurotransmitter is thought to lead to hypertension and sinus tachycardia, which in turn results in the abnormal regulation of emotion (Masterman & Cummings, 1997). To assess the motivational content of internal and external stimuli for the purposes of regulating context-dependent behaviors, the anterior cingulate region, a subsystem within the CAN, is implicated (Devinsky, et al, 1995).

Thayer and Lane (2000) cite support for their perspective through research with vagally mediated heart variability. According to Friedman & Thayer (1998), reduction in vagally mediated heart rate variability is consistent with cardiac symptoms of panic, anxiety, poor attentional regulation, and behavioral inflexibility. Brosschot & Thayer (1998) also related vagal inhibition to hostility. This research is thought to illustrate that when modulation of cardiac function is decreased, an individual is less able to track rapid changes in environmental demands and less able to recognize appropriate responses due to the relative speed of vagal influences (Saul, 1990; Thayer & Lane, 2000).

Research on lesions to the implicated neural areas is also thought to provide support for the model posited by Thayer & Lane (2000). According to the researchers, damage to the anterior cingulate is associated with altered attention, flattened affect, autonomic dysfunctions, and poor associative learning. Damage to this area is also associated with depression, anxiety, obsessive-compulsive disorder, and aggression (Thayer & Lane, 2000). Because of the dysfunction associated with damage to the anterior cingulate, the anterior cingulate is thought to integrate visceral, attentional, and affective information critical for emotion regulation and adaptability (Thayer & Lane, 2000). Work by other researchers demonstrating associations between rostral and ventral regions of the anterior cingulate to affect, motivation, and autonomic behavior are thought to support this conceptualization (Mayberg, 1997; Reiman, 1997). Further, Lane and colleagues (1998) demonstrated that the anterior cingulate is important to the selective attending of emotional responses as evidenced through PET scan imaging.

With regard to other structures that compose the CAN, Damasio (1994) suggested that the ventromedial frontal cortex and amygdala are necessary neural components that process emotion in advantageous decision-making. On a gambling task, Bechara, Damasio, Damasio, & Lee (1999) showed that adults with ventromedial frontal lesions made poorer decisions. Bechara and colleagues (1999) theorized that this finding was due to the impaired ability to effectively integrate somatic state information triggered by the amygdala as a result of the lesions.

The CAN provides both a theoretical and empirical framework for a physiological basis of emotional regulation, but relies primarily on the theoretical association between vagal inhibition and deficits in behavior. It does not take into account other physiological markers that may also be responsible for the healthy expression of emotional regulation. As is the case for other major constructs, it would be rare if emotional regulation only has one physiological cause. Therefore, it is necessary to delve further into the literature to attain a better picture of the physiological markers that more precisely reflect emotion regulation. Recent research has suggested that autonomic nervous system functioning as a whole may be better indicative of such regulation.

The Autonomic Nervous System

The autonomic nervous system controls the basic visceral functions of the body including cardiovascular activity and metabolism (Bubier, Drabick, & Breiner, 2009). The autonomic nervous system is composed of two subsystems: the sympathetic and the parasympathetic nervous systems. The sympathetic nervous system reacts to stress using the fight/flight response, which increases heart rate and oxygen flow throughout the body. It also deals with anabolic activities concerned with restoration and conservation of bodily energy, and the resting of vital organs (Boucsein, 1992; Muñoz & Anastassiou-Hadjiucharalambous, 2011). The parasympathetic nervous system is responsible for promoting growth, decreasing heart rate activity, and other restorative processes including returning the body back to baseline after a fight/flight response (Boucsein, 1992; Bubier, et al, 2009; Muñoz & Anastassiou-Hadjiucharalambous, 2011). Measurement of the autonomic nervous system is thought to assess emotional regulation as research of its two subsystems in response to stressors has been associated with depression and emotion dysregulation (Bubier, et al, 2009; Gross, John, & Richards, 2000; Kring et al, 1993; Sloan et al, 1997). Additionally, strong associations have been shown between behavioral measures of emotional regulation and autonomic reactivity (Carlson & Wang, 2007; Davis et al, 2010).Typically, autonomic functioning is determined using both markers from the sympathetic and parasympathetic divisions of the autonomic nervous system. In many instances, skin conductance and vagal tone have been used as markers for sympathetic and parasympathetic reactivity, respectively. Each of these markers has been theorized to account for different aspects of emotional regulation. To understand how these markers contribute uniquely to emotion regulation, analysis of each of type of marker is essential.

Vagal Tone

Vagal tone is the inhibitory process by which vagal efference during exhalation results in heart rate deceleration. Conversely, decreases in vagal efference during inhalation result in heart rate acceleration. The latter is thought to occur when sympathetic influences operate unrestricted during periods of vagal withdrawal (Porges, 2003). In research, vagal tone is typically indexed by respiratory sinus arrhythmia (RSA), which is defined as the cyclic increase and decrease in heart rate during respiration (Muñoz & Anastassiou-Hadjiucharalambous, 2011). As a measure for emotional regulation, one of the prominent theories advocating for vagal tone reactivity comes from Porges's (1995) polyvagal theory. Porges, Doussard-Roosevelt, and Maita (1994) state that when emotion occurs, the beating of the heart changes instantly. Change in cardiac activity is then thought to influence brain activity and brain stem structures, which in turn are thought to stimulate the heart via cranial nerves (the vagus in particular). The vagus, the tenth cranial nerve, originates at the brainstem and projects independently of the spinal cord to many organs in the body including the heart and the digestive system (Porges, Doussard-Roosevelt, and Maita, 1994). Through the vagus's functioning, a bidirectional vagus system is proposed to underlie emotional processes.

According to Porges (1995), vagal efferent (motor) fibers in the heart originate in the dorsal motor nucleus and nucleus ambiguss of the medulla. These efferents terminate on the sinoatrial node (which acts as the primary pacemaker of the heart). The dorsal motor nucleus controls the "vegetative" vagus, which mediates reflexive cardiac activity including the deceleration of heart rate associated with orienting and coping in more evolutionarily primitive organisms like reptiles. Thus, this pathway is seen as the evolutionarily "older" pathway (Porges, 1995). The subsystem proposed by Porges (2001) reliant on the dorsal motor nucleus and vegetative vagus is termed the "dorsal vagal complex" (DVC). To communicate information, the

DVC channels neural messages primarily through unmyelinated axons (Porges, 2001). The DVC is thought to be responsible for largely digestion and respiration (Porges, Doussard-Roosevelt, and Maita, 1994). It is also thought to be the mobilization system under which the sympathetic nervous system employs acetylcholine to prepare the body for action. It is not thought, though, to play a major role in the dynamic regulation of cardiac output. In mammals, its primary functions are thought to be associated with digestion, taste, and hypoxic responses (Porges, 2001).

Conversely, the nucleus ambiguss is associated with the “smart” vagus under the “ventral vagal complex” (VVC) subsystem (Porges, 2001). The smart vagus mediates RSA and originates in the nucleus ambiguss (Porges, 1995). It is suggested to have evolved in conjunction with the increasing demands of complex social interactions as it is thought to be responsible for the processes associated with motion, emotion, and communication (Porges, 2001). This vagus is conceptualized as uniquely mammalian and thus “newer” evolutionarily (Porges, 1995). Porges (2001) states that this system primarily communicates through myelinated axons. In terms of function, Porges argues that the deployment of this vagal system suppresses robust emotional reactions that characterize fight/flight responding; thus, it serves to inhibit strong emotional reactions (Porges, 1995). Further, Porges (1995) supports his claims by indicating that the fight/flight responding is accompanied by rage or panic responses which are facilitated by vagal withdrawal and characterized by large sympathetically mediated heart rate accelerations and fully attenuated RSA. Therefore, vagal withdrawal during intense emotional experiences is thought to be functionally adaptive in that it facilitates bursts of metabolic output to cope with perceived environmental demands. The vagus’s ability to inhibit strong emotional reactions is what Porges refers to as the “vagal brake”.

The vagus is thought to function through rapid inhibition and disinhibition of vagal tone to the heart because this allows an individual to rapidly mobilize or calm down (Porges, 2001). The vagal brake is employed when vagal tone is high because at this point, one's resting heart rate is substantially lower than the intrinsic heart rate of the sinoatrial node. If the brake is not working properly, Porges (2001) argues that functionally "older" systems (vegetative vagus) are recruited. Poorly regulated individuals are posited to be more irritable and reactive, and exhibit hypertension because deficits in their vagal brake force them to employ the evolutionarily older system (Porges, 2001). On the other hand, a functioning vagal brake allows one to be able to engage and disengage with objects, which in turns allows for the promotion of self-soothing behaviors and calm behavioral states (Porges, 2001).

The smart vagus system is also proposed to have branches that regulate the striated muscles of the head and face in addition to other visceral organs (Porges, 2001). Given this control, Porges (2001) suggests that this system also serves for emotional communication in response to threats or other stimuli through the exhibition of reactive emotion. Porges (2001) adds support to the communication function of this system by stating that the VVC also controls the larynx, pharynx, bronchi, and esophagus which are all essential to verbal communication. Taking into consideration the proposed communication and reactive emotional properties of this system, emotional regulation and social affiliation are considered emergent properties of the regulatory function of the smart vagus (Beacuchaine, Gatze-Kopp, & Mead, 2007).

Porges suggests that it is the coordination of these two vagal systems that provides emotional regulation. Specifically, these systems provide changes in response to sensory, cognitive, and visual challenges, which project to the central nervous system to regulate vagal efferents originating in the nucleus ambiguss and terminating in the heart and other associated organs (Porges, et al, 1994). These changes, in turn, support the expression of motion, emotion, and communication by regulating metabolic output (Porges, et al, 1994). When there are no environmental demands, the vagus addresses the needs of the internal viscera to promote growth and restoration. However, when challenges arise, homeostatic processes are compromised, and the autonomic nervous system provides support by reacting with increased metabolic output in the form of vagal withdrawal and sympathetic activation to deal with the challenges (Porges, et al, 1994). Under this framework, severe responses are thought to evoke fight/flight while less severe responses evoke emotional expression. These kinds of responses allow for the appropriate approach or withdrawal from objects or events in the environment (Porges, 1995). If functional deficiencies are present within the smart vagus, individuals are thought to be at risk for emotional lability. Emotional lability may then lead to abnormal behavior because the functional deficiencies in the vagus impair the coordination of this bidirectional vagal system (Beacuchaine, Gatze-Kopp, & Mead, 2007).

When analyzed from a theoretical perspective on emotions, the biological processes and resulting behaviors proposed by Porges map on well to the emotional regulation construct proposed by the social information processing model. Porges's model is a biologically based stimulus-organism response approach system by which expression and the regulation of emotions is dually determined by both the stimulus and the organism (Porges, et al, 1994). There is also empirical evidence by Porges and other researchers lending credit to the idea that vagal tone serves as a marker of emotional regulation.

In a review by Porges (1992), he demonstrated that higher vagal tone and appropriate suppression of vagal tone during demanding attention tasks led to better performance on those tasks. In more recent research, Porges (2003) indicated that vagal nerve stimulation is effective at treating depression. With regard to the work by other researchers, some studies indicate that excessive vagal reactivity to challenges is present in children who are perceived as shy or angrily reactive (Donzella, et al, 2000; Schmidt et al, 1999). Beauchaine (2001) suggests that deficiencies in vagal tone and excessive vagal withdrawal are associated with negative emotional trait states. Further, meta-analyses by Raine (1996) and Ortiz & Raine (2004) indicate that low resting heart rate is one of the best replicated biological markers of antisocial aggressive behavior in children and adolescents. Effect sizes for these findings were shown to be medium to large (Posthumus, et al, 2009).

In terms of RSA, Vasilev and colleagues (2009) demonstrated that emotion regulation strategies and impulse control obtained from emotion regulation scales (Gratz & Roemer, 2004) were significantly related to RSA reactivity over a three-year time period for preadolescent clinical and control samples. In Vasilev and colleagues' (2009) study, they demonstrated that increasing baseline RSA over the three year period was associated with fewer difficulties at the final assessment of emotion regulation. Beauchaine, Gatze-Kopp, and Mead (2007) also demonstrated that boys diagnosed with conduct disorder and oppositional defiant disorder had baseline RSAs that were significantly more attenuated compared to controls. In a 2007 study, Porges indicated that emotional expressivity in participants varied as a result of differing levels of RSA. Although the research highlighted appears to support RSA as a marker of emotional regulation, it is important to note that some studies do not support such a relationship (Blair et al 2004; Calkins & Keane, 2004; Donzella et al, 2000; Kidwell & Barnett, 2007). For this reason, it is important to examine RSA within its larger autonomic nervous system context.

Skin Conductance

Skin conductance is a measure exclusively regulated by the sympathetic nervous system (Glissen, et al, 2007). Like vagal tone, skin conductance responses are thought to be transiently altered by emotional stimuli (Bauer, 1998; Lang et al, 1993). Neural substrates responsible for skin conductance responses are thought to involve ventromedial and dorsolateral prefrontal cortices, the anterior cingulate, the parietal lobe, the insula, and the amygdala via the hypothalamus (Critchley, 2002). As such, skin conductance has been implicated with several regulative behaviors. Skin conductance is thought to be implicated in novelty seeking and impulsivity (Yoshino, et al, 2005). Skin conductance has also been associated with behavioral inhibition (Glenn, Raine, Venables, & Mednic, 2009).

The associations mentioned are significant because callous and unemotional traits in children have been associated with a lack of behavioral inhibition (Frick, et al, 2003). Thus, if skin conductance is implicated in behavioral inhibition, which in turn is a marker for callous/unemotional traits, skin conductance may serve as a predictor for problematic behavior. There is considerable empirical evidence that supports this implication. According to Bechara and colleagues (1996, 1997, 1999), when adults were faced with a gambling task, choosing advantageously was associated with an anticipatory skin conductance response thereby tying skin conductance with a reward system. With regard to functioning, a meta-analysis by Lorber (2004) found evidence indicating that children with conduct problems had lower skin conductance levels and conductance responses than controls. Posthumus (2009) replicated Lorber's findings in samples of high aggression, oppositional defiant disorder (ODD), and conduct disorder (CD) preschool children. Beauchaine and colleagues (2001) also found that compared to controls, children with attention deficit hyperactivity disorder (ADHD) and CD had reduced electrodermal responses. Based on their findings, Zahn and Kruesi (1993) suggested that boys with disruptive behavior disorders had slower declines in skin conductance during rest and stimulation periods. These boys also showed the strong impulsivity during a testing task. Lastly, Bubier and Drabick (2008) found that children who made poorer choices during a strategic game had decreased sympathetic arousal during emotional tasks. This lack in arousal was also related to an increase in hyperactive ADHD symptoms.

It is important to note that there is some research that links skin conductance to behavior in the opposite direction. According to this research, higher skin conductance levels are related to externalizing behaviors (El-Sheikh, 2005; Hubbard, et al, 2002). One of the aims of this study is to add clarity to the contradictory findings in both skin conductance and vagal tone from an overall autonomic nervous system framework.

Empirical research that has examined both vagal tone and skin conductance simultaneously has generally shown similar results. According to Beauchaine and colleagues, (2008) reduced electrodermal responding and lower resting heart rate predict both concurrent and future conduct problems and aggression in male preschoolers, middle-schoolers, and adolescents. Beauchaine and colleagues (2001) also demonstrated that compared to controls, ADHD and CD children had lower baseline RSA and reduced electrodermal responding. Snoek and colleagues (2004) found that children who exhibited externalizing problems had significantly lower heart rates at baseline and during stressful conditions when compared to controls. These children also had lower skin conductance levels.

With respect to engagement in frustrating tasks like the one used in the current study, Drucaroff and colleagues (2011) found that young adults who made better decisions on the task demonstrated increased sympathetic and decreased parasympathetic autonomic activity. Participant performance of learning and autonomic activation was most evident in the later blocks of time in which the participant was assessed. Active learning of the task in later blocks of time of assessment has been supported in other research examining the validity and reliability of the task (Lin, et al, 2013; Worthy, Hawthorne, & Otto, 2013).

The substantial amount of evidence associating autonomic nervous system reactivity with behavior suggests that the use of vagal tone and skin conductance may be appropriate in the assessment of emotion regulation. However, given the contradictory findings in some of the literature, it is important to interpret any conclusions drawn from the literature with caution. The linear relationships linking these physiological markers (higher baseline RSA and higher levels of skin conductance) with healthy emotion regulation may not be as straightforward as they seem. Given the complexity of the neural pathways and brain structures implicated in emotional regulation, different processes and varying levels of reactivity may have a differential impact on emotion regulation. Boyce and Ellis (2005) provide a theoretical model for just how varying reactivity may impact emotion regulation.

Boyce & Ellis (2005) Theory

Boyce & Ellis's (2005) conceptualization of self-regulation incorporates neuroendocrine function as Porges (2001) suggested. Boyce and Ellis argue that these pathways are among the dysregulatory pathways by which psychological trauma is converted into pathogenic biological processes (Boyce & Ellis, 2005). The stress-illness relationship they refer to is thought to be initially based in the differences of individual organism characteristics. Specifically, individual constitutional variation in susceptibility to change is what is thought to be responsible. This variation is thought to manifest itself in individual differences in reactivity (Boyce & Ellis, 2005).

When referring to reactivity, Boyce and Ellis use Matthews's (1986) term defining reactivity as a "deviation of a physiological response parameter from a comparison or control value that results from an individual's response to a discrete environmental stimulus". Simply stated, Boyce and Ellis dichotomize reactivity when presenting their model into individuals with high reactivity and those without. Boyce and Ellis (2005) state that traditionally, highly reactive individuals were viewed as atavistic in the sense that their reactivity was thought to commensurate with the threats of prehistoric humans in an environment that was no longer applicable. This traditional view also placed highly reactive individuals at higher risk for mental disorders because their reactivity was only revealed by traumatic experiences (Boyce & Ellis, 2005). In other words, these individuals exhibited high reactivity due to a high biological sensitivity to context. Although this view of highly reactive individuals was not completely done away with, Boyce and Ellis propose other frameworks for highly reactive individuals.

According to their hypothesis, Boyce and Ellis (2005) state that highly stressful and highly protective environments both yield disproportionate numbers of highly reactive children. Thus, rather than a linear relationship between reactivity and stress, Boyce and Ellis propose a curvilinear relationship between early adversity and reactivity. Boyce and Ellis (2005) argue that highly reactive phenotypes are forms of enhanced, neurobiologically mediated sensitivity to context. These particular phenotypes have been favored due to natural selection as a result of the advantages gained in high and minimal stress environments. Reminiscent of Porges's (1995) polyvagal theory in terms of evolutionary utility, Boyce and Ellis (2005) argue that biological sensitivity to context increases adaptive competence in highly stressful environments by enhancing vigilance to threats and dangers. In highly protective environments, biological sensitivity to context is adaptive in the sense that it increases susceptibility to social resources and ambient support (Boyce & Ellis, 2005). Much like Porges's (1995) model, this too is a stimulus-organism model in the sense that physiological emotional regulation reactivity is mediated by the environment. For detailed information on the biological systems deemed responsible for this conceptualization of physiological emotion regulation, refer to Boyce and Ellis (2005).

Boyce and Ellis (2005) find some support in the literature for their model. Boyce and colleagues (1995) demonstrated that physiological reactivity in children ages three to five in high stress families was related to higher rates of respiratory illness when compared to their less reactive peers. In support of the curvilinear relationship, highly reactive children in low stress settings were also reported to be the healthiest (Boyce, et al, 1995). Similar findings were found for an Appalachian sample of children with regard to the association between low adrenocortical reactivity and the diagnosis of conduct disorder (Boyce & Ellis, 2005). Parallel findings were also found when assessing memory in high or low social support environments for highly reactive children (Quas, Bauer, & Boyce, 2004).

In terms of behavioral functioning, Ellis, Essex, and Boyce (2005) conducted a study measuring family stress, socioeconomic status, cortisol, heart rate, blood pressure, RSA, and pre-ejection period. Their results indicated that the different forms of high physiological reactivity were marked by either high or low levels of family stress. These results provide support for the argument that high levels of reactivity may be predicted by both supportive and unsupportive environments.

The current study aims to provide support to the notion of physiological emotion regulation through the examination of autonomic functioning with other variables (parental involvement, temperamental traits, and externalizing behaviors) that have been traditionally analyzed alongside behavioral assessments of emotion regulation. In light of the described research, autonomic markers are specifically chosen for analysis.

Methodological Considerations for Autonomic Markers

The aforementioned research with the autonomic nervous system and emotional regulation provide reasonable support for RSA and skin conductance as markers for physiological emotion regulation. However, these markers are not without their concerns. Although no notable concerns were found with regard to the assessment of skin conductance, measurement of vagal tone does pose some issues for consideration. According to Porges and Bohner (1990), quantification of periodic processes may be inaccurate if not quantified correctly because physiological data is not stationary. More specifically, given the continuity of one’s heart rate, nonsinusoidal data cannot be forced to fit a particular heart wave because heart waves consist of both periodic and aperiodic components (Porges & Bohrer, 1990). Therefore, appropriate detrending procedures and filters are recommended when analyzing heart rate data (Porges & Bohrer, 1990).

When assessing vagal tone through the indexing of RSA, the method by which RSA is calculated must be considered. According to the literature there are currently three ways of calculating RSA: peak-to-valley quantification, spectral analysis, and Porges’s vagal tone method (Grossman, VanBeek, & Wientjes, 1990). The peak-to-valley method measures the difference in milliseconds between the shortest heart period interval accompanying inspiration and the longest interval accompanying expiration. Differences are then averaged across breaths in the measurement period. With spectral analysis, a heart period time series is decomposed into components with mutually exclusive bandwidths. RSA is then partitioned within the frequency band of the respiration rate. Non-rhythmic components are then subsequently removed from the series via a statistical detrending procedure involving the use of Fourier and Fast Fourier transformations. Porges's vagal tone method moves a polynomial equation of variable length stepwise through the data. Variance is then estimated for the remaining filtered time series of points within the presumed respiratory band to derive RSA. Some research indicates that all three RSA quantification methods are highly correlated, and, thus, functionally equivalent indices of cardiac vagal tone (Grossman, VanBeek, & Wientjes, 1990). However, Porges (2007) argues that highly correlated quantification methods do not imply that they are functionally equivalent. Porges (2007) states that to derive precise cardiac vagal tone, one must examine the effect size in response to known methods of vagal blockade (the blocking and unblocking of outflow from the myelinated source nuclei); which he proposes his RSA quantification method does well. In line with this argument, some researchers state that spectral analysis or Porges's vagal tone method should be used given that the correlation between RSA and vagal tone may drop to 0.5-0.7 due the variability in respiration rate and tidal volume interference when using the peak-to-valley method (Grossman, VanBeek, & Wientjes, 1990). Therefore, for the purposes of this study, Porges's vagal tone method will be used.

Why Assess Emotion Regulation with Physiological Markers over Paper-Pencil Measures?

Physical markers may be better indicators of emotional regulation in that they are less biased and uncensored and more sensitive and mechanistic in comparison to paper and pencil measures (Blascovich, Vanman, Mendes, & Dickerson, 2011). Although there is some evidence indicating that there is a high correlation between self-report measures of emotional regulation and physiological reactivity, these self-report measures have only been normed on adult samples according to the reviewed literature (Gratz & Roemer, 2004). Other research only correlates specific physiological reactivity with specific scales/subscales of various measures without considering self-regulation as a global construct (Carlson & Wang, 2007; Davis et al, 2010). Further, several of these paper-pencil measures involve self or parent-report of emotion regulation. According to a meta-analysis by Achenbach, McConaughy, & Howell (1987), the informant influences the accuracy of the data that is collected. Specifically, Achenbach and colleagues showed that when comparing similar informants (like one parent to another) the correlation was medium (Pearson r of 0.60). However, when it came to analysis across informants (parent-child; parent-teacher), the effect was small (r=0.22 & 0.28 respectively; Achenbach, McConaughy, & Howell, 1987). These limitations are presented in addition to the inherent limitations of self and observer-report methods (e.g. faking good, faking bad, observer biases, etc; Gazzaniga, Heatherton, & Halpern, 2010).

From a developmental standpoint, physiological markers of emotional regulation may be more appropriate for the preadolescent sample of study. According to the literature, repeated assessment of stress reactivity indicates that high reactivity levels to not appear until preadolescence suggesting that a biological sensitivity to context may be developmentally "canalized" by the environment (Allen & Matthews, 1997; Ellis, Essex, & Boyce, 2005). Therefore, physiological emotional reactivity may be best assessed when children enter the preadolescent stage. Although no single biological system has been deemed completely responsible for self-regulation because it is generally accepted that self-regulation has multiple systemic inputs, specific indicators like vagal tone have shown to serve as accurate indicators of behavioral reactivity and regulation (Beacuchaine, 2001; Porges, 2007; Porges, Doussard-Roosevelt, Portales, & Seuss, 1994).

Temperament versus Physiological Regulation

Superficially, the constructs of temperament and physiological emotion regulation may seem similar, but there is one key distinction. Physiological markers assess emotional and behavioral *reactivity* (and as such regulation) of noxious stimuli, and are thus, automatic processes (Boyce & Ellis, 2005; Porges, 1995; Thayer & Lane, 2000). The temperamental dimensions being analyzed, on the other hand, incorporate *conscious* control. Effortful control is a learned and inherent conscious process (Carlson & Wang, 2007; Zelazo, et al, 1997), which is designed to purposefully moderate other more constitutional dimensions like negative affect (Posner & Rothbart, 2000). The primary distinction between the temperamental dimensions being examined and emotional regulation, therefore, is a matter of how the construct processes are activated by the time a child reaches adolescence.

The temperamental traits of study involve controlled processes that have developed from the interaction between genetics and maturation in the environment; whereas a child's physiological emotion regulation, although also shaped by environmental forces, remains under the direction of unconscious automatic processes. Therefore, given the consciousness distinction between temperament traits and physiological reactivity, it can be argued that unconscious automatic processes are more difficult to capture on paper-pencil measures because they require the subject to give conscious responses. Physiological assessments, on the other hand, do not require any conscious effort on the subject's behalf. As such, physiological markers may be more accurate at portraying emotional regulation as defined by the aforementioned physiological research (Boyce & Ellis, 2005; Porges, 1995; Thayer & Lane, 2000). If this is the case, the implications for physiological emotion regulation assessment are significant in that researchers could potentially predict outcome behaviors from biological markers rather than having to rely on self or observer-reported contextual/behavioral risk factors from paper-pencil methods.

Parental Involvement

Parenting has been implicated in a range of behaviors and developmental trajectories whereby better parenting practices typically lead to healthier outcomes (Denham, et al, 1997; Eiden, Colder, Edwards, & Leonard, 2009; Garner, 1995; Noel, Peterson, & Jesso, 2008; Ramsden & Hubbard, 2002; Stormshak, 1996). In light of the current study, the reviewed research denotes parental involvement as a key dimension in the development and prevention of externalizing symptoms (Baumrind, 1991; Maccoby & Martin, 1983; O'Connor, 2002; Reitz, Decovic, & Meijer, 2006; Scott, Briskman, & Dadds, 2011). For instance, Pardini, Lochman, & Powell (2007) found that high levels of positive involvement predicted lower levels of callous/unemotional traits over time, which could lead to aggression. This finding was independently supported in a later study by Hawes, Dadds, Frost, & Hasking (2011). Similarly, lower levels of positive parental involvement have been linked with greater levels of conduct problems, aggression, delinquent behavior, and antisocial behavior in children and adolescents (Essau, Sasagawa, & Frick, 2006; Reitz, Dekovic, & Meijer, 2006; Scott, Briskman, & Dadds, 2011). Higher levels of positive parental involvement have also been shown to increase the number and variety of coping strategies used when confronted with a stressful situation in a sample of diverse 9-10 year-old children (Hardy, Power, & Jaedicke, 1993). The research presented suggests that positive parental involvement may be a critical predictor of externalizing behavior, but its role may extend beyond the direct associations mentioned.

The current study examines whether positive parental involvement is significantly involved in the development of externalizing behavior beyond the linear relationships found in the literature. There is some current research that has examined the roles of parental involvement and either temperament or emotion regulation when predicting externalizing behavior, but little research has been done examining all three constructs simultaneously. The research linking parental involvement to temperament suggests that that there may be a mediating or moderating relationship. In a sample of children followed from ages two to five, for example, children with less difficult temperaments whose parents were more involved experienced a decrease in externalizing behaviors (Mesman, et al, 2009). When examining specific temperamental characteristics, some research indicates that parental involvement moderates the temperament-behavior relationship. Karreman and colleagues (2009) found that in pre-K children, positive parental involvement moderated the relationship between poor effortful control and externalizing problems. In a similar study, Crawford, Schrock, and Woodruff-Border (2011) demonstrated that negative maternal involvement mediated the relationship between effortful control and internalizing symptoms.

Research also indicates that parental involvement may influence how effortful control is developed (Cipriano & Stifter, 2010). This research suggests that higher involvement may yield greater control or vice versa. However, it is difficult to tell whether this relationship continues to exist as the child matures and whether it contributes to externalizing behavior because most of this research has been conducted with pre-K or younger samples. This study examines whether these kinds of relationships persist as the child develops by examining the constructs with at-risk preadolescents.

With regard to the link between parental involvement and emotion regulation, when measured by non-physiological assessments most research suggests a link, but the direction of that link is unclear. Akker, Dekovic, Prinzie, & Asscher (2010) state that positive parental involvement predicts healthier levels of emotion regulation in pre-K children whereas Bridgett and colleagues (2010) indicate that the poor emotion regulation is predictive of more negative parental involvement in 4-12 month infants. Other research suggests that emotion regulation may have more of a mediating role between parental involvement and functioning (Ramsden & Hubbard, 2002). Conversely, parental involvement has also shown to have a mediating role on the relationship between emotion regulation and functioning (Bryan & Dix, 2010). Given these relations, there is likely an association between emotion regulation and parental involvement that persists into adolescence. In terms of physiological functioning, there is a relative dearth of research directly examining autonomic functioning with parental involvement. However, there is some research linking autonomic functioning with some of the parenting practices to which parental involvement has been linked.

Belsky's (1997, 2000) theory emphasizes individual differences in susceptibility to rearing influences. Under Belsky's theory, some individuals are less susceptible to parental influence due to genetic endowment, while others have traits that are more plastic and susceptible to rearing influence. In his research, Belsky (2000, 2005) demonstrated that negative emotionally reactive infants appeared more susceptible to rearing influences thereby lending some credit to Boyce and Ellis's (2005) framework regarding reactivity.

When skin conductance has been assessed, children who have experienced harsh parenting and hostility exhibited low levels of skin conductivity, which in turn predicted higher levels of delinquency and externalizing behavior (Dierckx et al, 2011; Erath, El-Sheikh, Hinnant, & Cummings, 2007). In related research, skin conductance reactivity predicted the quality of the parent-child relationship (Glissen, et al, 2007). In terms of heart rate and RSA, children who were exposed to martial conflict exhibited reductions in RSA, which elicited vagal withdrawal (El-Sheikh, et al, 2007, 2009). Given parental involvement's associations to these other parenting characteristics, it is important to analyze whether physiological reactivity has similar relationships to parental involvement in the prediction of externalizing behavior. Doing so would determine whether the relationships between parent/child-report of emotion regulation and parental involvement can be replicated with physiological data, and would add clarity as to whether parental involvement is associated with physiological emotion regulation. The current study analyzes such relationships.

The Present Study

This study examines the pathways among temperamental dimensions (negative affect and effortful control), physiological emotion regulation as measured by autonomic functioning, positive parental involvement, and externalizing behaviors as presented in Figure 1. Few studies have examined these variables simultaneously, and none have examined the specified pathways with an “at-risk” preadolescent sample in the reviewed literature. The temperament research suggests that both negative affect and effortful control predict externalizing behaviors, but the mechanisms by which they operate are less understood (Carlson &Wang, 2007; Dennis, Hong, & Solomon, 2010; Hare, 2003; Penney & Moretti, 2006). Some research suggests that negative affect is a relatively stable temperamental trait that impacts behavioral functioning whereas effortful control is temperamental trait that develops as the child matures as a result of the interaction between genetic predisposition and the environment (Rothbart, et al, 2000). Further, effortful control’s later development and its conceptualization as a child’s cognitive control system (Willowski, Robinson, & Troop-Gordon, 2010) suggest that it may have more of a moderator role with regard to the other variables (Carlson & Wang, 2007; Liew et al, 2004; Pardini, Lochman, & Wells, 2004; Posner & Rothbart, 2010). This research suggests that effortful control may serve as a buffer against the negative influence of a child’s stable negative affect.

According to some research, appropriate behavior stems from the healthy development of a regulatory system (Dennis, et al, 2009; Eisenberg, et al 2001; Gilliom et al 2002). As such, whereas stable temperamental traits may be the foundation upon which a child's regulatory system is built, the literature suggests that it is the child's ability to respond appropriately to noxious environmental stimuli that impacts behavior directly (Bowie, 2010; DeCastro, et al, 2005; Sullivan, et al, 2010). Specifically, given the limited research with pre-K children implicating negative affect in the development of appropriate physiological regulation (Dougherty, Klein, Olino, Dyson, & Rose, 2009), it is hypothesized that (H-1) negative affect is the specific temperamental trait that predicts autonomic reactivity, which in turn (H-2), predicts externalizing behavior. As noted by Boyce and Ellis (2005) and Porges (1995), there are links between brain structures and autonomic functioning suggesting that autonomic markers may be indicative of such emotional reactivity to environmental stress. One of the aims of the current model is to add support to the notion that physiological reactivity is the regulating system by which negative affect predicts externalizing behavior.

The model also hypothesizes that effortful control moderates the relationship between autonomic reactivity and externalizing behaviors (H-3). Effortful control's suggested role as a child's cognitive control system implies that there is some conscious control in the inhibition of reactive responses (Rothbart & Rueda, 2005). As such, if a child has deficient autonomic reactivity levels in response to a stressor, a child high in effortful control may be able to compensate for such deficiencies through the conscious cognitive inhibition or activation of behaviors. Additionally, effortful control's role as a moderator is proposed for the autonomic mediation of negative affect and externalizing behaviors. This moderated mediation is noteworthy given that some researchers have suggested that effortful control does not directly contribute to externalizing behaviors. Rather, these researchers pose that effortful control may regulate externalizing behaviors by indirectly controlling the reactive tendencies underlying negative affect (Posner & Rothbart, 2000).

With regard to positive parental involvement, the association between parental involvement and externalizing behaviors is well established (O'Connor, 2002; Reitz, Decovic, & Meijer, 2006; Scott, Briskman, & Dadds, 2010). However, the pathways by which parental involvement predicts externalizing behavior are less understood. This study hypothesizes that positive parental involvement acts as a mediator between a child's negative affect and his or her expression of externalizing behavior (H-4). Some research supports either a mediating or moderating role with pre-K samples, but no research reviewed studies this relationship with an at-risk preadolescent sample.

Given that the target sample for this study is in the preadolescent stage of development, it is important to note that parental involvement may not be as influential in predicting externalizing behavior because as children approach adolescence, the developmental literature states that children attempt to distance themselves from their parents in an attempt to develop an independent sense of identity (Gazzaniga, Heatherton, & Halpern, 2010). Other research indicates that parental observations with older children may not be as useful, but may continue to still hold significance if children are of middle childhood age or younger (Keller, 1986; Shelton, Frick, & Wootton, 1996). Given that the proposed sample is at the cusp of adolescence, parental involvement is still deemed important to future behavioral outcomes (Gazzaniga, Heatherton, & Halpern, 2010). Thus, it is thought that during this particular developmental stage, parental development may mediate rather than moderate a child's temperamental traits as is suggested by some of the pre-K research (Karreman, et al, 2010; Mesman, et al, 2009).

In terms of parental involvement's connection to emotion regulation, behavioral measures of emotion regulation have predicted and been predicted by emotional regulation (Akker, et al, 2010; Ramsden & Hubbard, 2002). Similarly, markers of autonomic functioning have also predicted and been predicted by parenting practices (Dierckx et al, 2011; Erath, et al, 2011; Glissen, et al, 2007). When examined together, these studies suggest a stable association between positive parental involvement and emotional regulation. This study examines whether the proposed relationship between parental involvement and autonomic reactivity is maintained in an at-risk preadolescent sample (H-5).

It is important to note that the reporting of externalizing child behavior is often not highly correlated among sources. According to prior literature, there is modest agreement between parent and teacher report of externalizing behavior (Achenbach, et al, 1987; Connolly & Vance, 2010; Dinnebeil et al, 2007; Renk & Phares, 2004). The modest agreement appears to be due to a variety of factors. These factors may include setting effects, differential reporter bias, reporter psychopathology, and the presence of comparable peers (Kuppens, et al, 2009; Phillips & Lonigan, 2010; Graves, Blake, & Kim, 2002). To account for parent-teacher discrepancies in report of behavior, the current study examines teacher and parent report of externalizing behavior in separate models.

Overall, although the proposed model is exploratory in nature, the relationships posited are conceptually grounded in the literature and developmental research described above. The findings for this study also highlight important implications for the treatment and prevention of externalizing behavior in at-risk youth.

METHOD

Participants

The data from 360 participants was used. The participants for the present study were recruited during their fourth grade year. Participants were recruited as part of a larger study assessing the effectiveness of the Coping Power program, an intervention targeted toward aggression prevention strategies. The current study used baseline data for all recruited participants prior to their exposure to the intervention to avoid any potential intervention effects. Participants were recruited from twenty public schools over a three-year period in north central Alabama and included a range of urban and suburban schools. Participants were rated as “high-risk” for aggression by their teachers and parents using a multiple-gating approach. This approach consisted of a primary gate which involved teacher ratings of student aggression and a second soft gate involving parent ratings of aggression. The first gate involved third grade teachers rating all their students on the *Teacher Report of Reactive and Proactive Behaviors,* developed by Dodge and Coie (1987) at the end of the third grade year to obtain an overall aggression score. In this measure, teachers rate the frequency of six aggressive behaviors on a 5-point scale (total scores range from 6 to 30). Students who were rated in the top 25% of this aggression measure were then subjected to a second gating process before being invited to participate. The second gate involved examination of parent-reported scores on the Aggression subscale of the Behavior Assessment System for Children, 2^{nd} edition (BASC-II; Reynolds & Kamphaus, 2004). To pass this second gate, parent scores on the Aggression subscale must have exceeded a T-score of 40. This benchmark was set to exclude children that parents rated as non-aggressive. A similar screening system has been found to be valid and stable over time (Hill et al., 2004; Lochman & CPPRG, 1995). The selection criterion (25%) was based on the distribution of teacher ratings across all of the third-grade classes, rather than identifying the 25% most aggressive children in each class.

Notification of the first gate screening procedures were sent to the parents of potential participants in the Fall of the children's fourth grade year. Parents whose children passed the first gate were then provided with the Aggression subscale of the BASC-II to complete. If their children met criteria for participation, researchers used the information provided by the participating school systems to contact the children's caregivers regarding participation. Obtainment of consent and the pre-intervention (baseline) assessment began during the winter of the children's fourth grade year. Assessment measures were collected from primary caregivers and from children in their homes. Participant compensation at assessment was $50 per parent and $10 per child.

The sample was 65% male (n=234). In terms of race and ethnicity, 76% of the sample identified as Black/African American (n=273) and 21% (n=75) identified as White. Socioeconomically the sample could be classified as low-middle to working class. Of the 360 participants, 62% of the youth (n=223) had household incomes below $30,000.

Measures

EAT-Q

Temperament is being assessed using the Early Adolescent Temperament Questionnaire – Parent Report (EATQ-P; Ellis & Rothbart, 2001). The EAT-Q is a parent report measure designed to assess Rothbart's 11 dimensions of temperament in children (Rothbart & Derryberry, 1981). Parents are asked to indicate the truthfulness of each of 52 statements on a 5-point scale. The Effortful Control construct was derived from the Approach, Inhibitory Control, and Activity scales. These scales demonstrated Cronbach's alphas of 0.50, 0.41, and 0.65 respectively. When the items of all these scales were tested in a reliability analysis, they demonstrated a Cronbach's alpha of 0.66. Negative Affect was derived from the Shyness, Positive Affect, and Fear scales. These scales had Cronbach's alphas of 0.25, 0.78, and 0.37 respectively. When the items of all Negative Affect scales were examined in a reliability analysis, they demonstrated an improved Cronbach's alpha of 0.54.

The constructs of Effortful Control and Negative Affect have been supported in previous factor analyses of the measure (Putnam, Ellis & Rothbart, 2001). The EAT-Q has also been shown to be valid and reliable across several studies (Bush, Lengua, & Colder, 2010; Capaldi & Rothbart, 1992; Sentse et al, 2011; Valiente, Lemery-Chalfant; Swanson, & Resier, 2010; Wong, 2008).

Alabama Parenting Questionnaire

Parental Involvement was assessed by parent self-report on the Parent Involvement scale of the Alabama Parenting Questionnaire (APQ; Shelton, Frick, & Wootton, 1996). The APQ has 42 questions for which the parent responds how often different parental behaviors occur in the home. Parents respond to items using a 5-point frequency scale (1=never to 5=always). Higher scores indicate greater levels of positive parental involvement. The APQ has demonstrated good reliability and validity across several studies (Clerkin, Marks, Policaro, & Halperin, 2007; Essau, Sasagawa, & Frick, 2006; Randolph & Radey, 2011). Additionally, the APQ has shown good associations between its scales and conduct problems in clinic-referred children and adolescents (Blader, 2004; Chi & Hinshaw, 2002; Essau, Sasagawa, & Frick, 2006; Frick, et al, 1999; Hinshaw, 2002). The APQ has also been shown to differentiate between children with disruptive behavior disorders and controls (Shelton, Frick, & Wooton, 1996).

The parental involvement scale has shown one of the highest reliabilities across informants and other scales in previous research (Shelton, Frick & Wooton, 1996). Examples of items from the Parent Involvement scale include talking and playing games with one's child, helping with his/her homework, and helping with activities in the child's life. In this study, the Parent Involvement scale demonstrated a good Cronbach's alpha of 0.79.

BASC-II

Child externalizing behaviors were assessed using parent and teacher report on the BASC-II (Reynolds & Kamphaus, 2004). Respondents answer "never", "sometimes", "often", or "almost always" for each item. Higher scores indicate higher levels of behavior problems. Aggression, Conduct Problems, and Hyperactivity subscales were used to derive the Externalizing Behavior latent constructs. These subscales have shown good psychometric properties when used in an externalizing composite (Reynolds & Kamphause, 2004). BASC-II reports for externalizing behaviors have consistently shown good reliability and validity across ages and informants (Reynolds & Kamphaus, 2004).

Parent reported aggression, conduct problems, and hyperactivity scales demonstrated good Cronbach's alphas of 0.82, 0.75, and 0.83 respectively. When all the items for these scales were examined in a reliability analysis, they showed an excellent Cronbach's alpha of 0.91. With regard to teacher report, aggression, conduct problems, and hyperactivity scales showed good to excellent Cronbach alphas of 0.92, 0.73, and 0.90 respectively. When all teacher-reported items were examined in a reliability analysis, they demonstrated an excellent Cronbach's alpha of 0.94.

Physiological Markers

Physiological markers were assessed using heart rate and skin conductance data recorded by a Biolog, a portable, ambulatory physiological data recorder available commercially. The

Biolog was connected and attached to the participant through bioelectric and transducer input assemblies. The Biolog has a microprocessor system that allows the data to be simultaneously recorded and stored. To measure heart rate/ interbeat intervals (collected for the derivation of RSA), one electrode was placed just above the collarbone of a participant's right side, another electrode was placed behind the participant's left knee, and a reference electrode was placed on the right side of the participant's neck. To measure skin conductance, electrodes were placed on the volar surface of the distal phalanx of the first and third fingers of the non-dominant hand.

Each participant viewed a 3-minute video after the placement of the electrodes. The video was chosen specifically to be neutral in content and unlikely to evoke an emotional reaction. The purpose of this procedure was to allow the participant to acclimate to the testing equipment so that any physiological response resulting from the participant's unfamiliarity with the device would not confound measurements. After the video, the child was asked to participate in a decision-making task designed to invoke frustration, and thus stress in the child to determine how these physiological markers responded to noxious stimuli.

RSA was derived using the procedures outlined in the manual *Inter-Beat-Interval Editing for Heart Period Variability Analysis: An Integrated Training Program with Standards for Student Reliability Assessment* (2007). This manual is designed to be used in conjunction with the *CardioEdit* and *CardioBatch* computer programs developed by Dr. Stephen Porges, director of the Brain and Body Center at the University of Illinois. The first step toward deriving RSA involved cleaning the interbeat interval data collected by the Biolog. This process consisted of hand editing each participant's heart rate data in order to remove any unwanted artifacts according the techniques outlined in the manual. Artifacts in the heart rate data are errors that appear in the interbeat interval data that are likely due to the digitizing process of the data or to physiological anomalies. Once the data was cleaned, RSA was extracted from one of the predominant rhythms exhibited in the data. This RSA extraction occurred through computations of the participant's heart period series using the computer software.

The physiological recording process involved the recording of a baseline period and five subsequent blocks of time. The five blocks represent the time in which the participants was engaged in the frustrating task. Given that the current study focuses on physiological regulation of emotion, reactivity scores of physiological activity were derived and used in analysis. Reactivity scores for each block were created by subtracting baseline from block values of RSA/SCL. During the first two blocks, the participant was largely getting accustomed to the frustrating task, so the latter three block reactivity scores were used in analyses given that they are likely more representative of regulation (Lin, et al, 2013; Worthy, Hawthorne, & Otto, 2013).

Analytic Procedure

Structural equation modeling techniques were used to assess the significance and fit of the proposed model. The fit and significance for the model was assessed by the Mplus computer software (version 6) designed by Muthén and Muthén (2007) using the methods outlined in their manual. These methods involve coding of database/variable identifiable information and path/model specification. Once this data has been entered in the program, the computer software runs the model and produces several fit indices along with other statistical data including path coefficients for each of the proposed relationships in the model and their corresponding statistical significance (p-value). To ascertain best fit, the following fit indices were used to assess the significance of the model: Likelihood ratio chi-square (χ^2), Root Mean Square Error of Approximation (RMSEA), Standardized Root Mean Residual (SRMR), Comparative Fit Index (CFI), and the Tucker-Lewis Index (TLI; also known as the non-normed fit index; NNFI). These indices have been established in the literature as adequate measures of fit and significance (Fan, Thompson, and Wang, 1999; Schumacker & Lomax, 2010; Steiger, 1990; Ullman, 2001). Path coefficients were estimated using the maximum likelihood estimation and then analyzed to determine significant relationships among the variables.

Given that the current model involves moderated mediation, additional statistical methods were employed. For the purposes of this study, the procedures outlined by Preacher, Rucker, and Hayes (2007) were used. Specifically, analyses used procedures from Preacher, Rucker, and Hayes' (2007) third moderated mediation model. In this model, an outside variable moderates the second path of the mediation. With regard to this study's model, effortful control is hypothesized to moderate the relationship between autonomic functioning and externalizing behaviors. As can be seen in Figure 1, the path being moderated is the second path of autonomic reactivity's mediation. Equations for the appropriate indirect effects involving effortful control were entered into the software as described in the moderated mediation literature (Edwards & Lambert, 2007; Preacher, et al, 2007). To account for the moderator's influence on the second path, expressions accounting for the moderator's direct influence on the dependent variable and its interaction with the mediator were also entered into the statistical program. The output was then analyzed as outlined by Muthén and Muthén (2007).

In consideration of assumptions of normal distribution for product terms, the bootstrap method was conducted for all parameters in the proposed model as the bootstrap method does not rely on assumptions regarding the shape of the sampling distribution (Edwards & Lambert, 2007; Preacher et al, 2007). The bootstrapping method essentially generates a sampling distribution of the product of two regression coefficients by repeatedly estimating the coefficients from multiple samples drawn from the original sample with replacement to generate confidence intervals for the conditional indirect effect (Edwards & Lambert, 2007; Efron & Tibshirani, 1993; Mooney & Duval, 1993; Preacher et al, 2007).

Missing Data

Participants with missing data were compared to those without. No significant differences were discovered. Multiple imputation procedures were conducted as detailed by Enders (2010) to allow for the highest sample size possible. Having a larger sample size allowed for greater power in the study's SEM analyses.

RESULTS

Preliminary Analyses

Descriptive statistics are presented for all study variables (Table 1). Of note, only baseline and blocks 3-5 were reported given that it was the data from these variables that was used in the structural models to be described. Reactivity scores were created for the physiological variables by subtracting each block value from the baseline value (Boyce, et al, 2001). Descriptive statistics for these reactivity scores in relation to other study variables can be found in Table 2. Like with Table 1, only physiological reactivity blocks 3-5 were used. Some general relationships were evident in these correlations. Indicators of negative affect significantly correlated with indicators of effortful control whereby higher negative affect predicted lower levels of effortful control. Additionally, indicators of negative affect predicted teacher reports of externalizing behavior whereas effortful control predicted parental reports of externalizing behavior. With regard to parental involvement, parental involvement significantly predicted indicators of both negative affect and effortful control as well as parental, but not teacher report of externalizing behavior. Higher parental involvement is related to higher levels of effortful control and lower levels of negative affect and externalizing behavior.

Prior to describing the relations to physiological variables, it is important to consider baseline versus reactivity scores. Correlations to baseline indicators theoretically illustrate relations between study variables and an individual's static physiological state while reactive indicators demonstrate relations in terms of regulative ability. With regard to baseline measures of physiological activity, results indicated that the Approach indicator of effortful control was predicted by some of the SCL blocks. Lower SCL levels predicted higher approach. Parental involvement also demonstrated a negative correlation with SCL block three suggesting that lower SCL levels predict higher levels of parental involvement. Lastly, various RSA and SCL blocks correlated negatively as was expected given that each is a marker for a reciprocal branch of the autonomic nervous system.

With respect to the reactivity scores of the physiological variables, results indicated that RSA reactivity scores predicted lower levels of inhibitory control. RSA reactivity also predicted parent, but not teacher reported externalizing behavior. Higher RSA reactivity predicted higher levels of problem behavior.

Given that the focus of this paper is physiological emotion regulation as it relates to externalizing behavior in the context of the other variables of study, the structural models that will be presented used reactivity rather than the static physiological scores for all participants. Four key models will be described that are variants of the original model proposed. As will be detailed below, these models were derived because of poor fit and specification issues. Refinements of these models will be described following each model's presentation.

Structural Models

Structural models were analyzed using Mplus version 6.0 (Muthén & Muthén, 2010). To obtain physiological latent constructs only the last three reactivity blocks were used because this is when the participant is actively engaged in learning the task and when frustration is invoked. The first model tested is depicted in Figure 1. The residual variances for latent constructs were set to one unless otherwise noted. When initially run, the model converged with an error indicating that the latent variable covariance matrix (psi) was not positive definite. Specifically, Effortful Control produced a negative correlation greater than one with Negative Affect. Additionally, the Activity indicator produced negative residual variance. To remedy this error, the residual variance of Activity was set to zero. After this modification, the model ran, but Mplus output indicated that the standard errors of parameter estimates may not be trustworthy due to model non-identification. This model provided the following poor fit statistics: χ^2 = 33,026.96 (df=847, p<0.00), RMSEA = 0.14, SRMR=0.13, CFI=0.37, and TLI=0.33.

After reviewing the correlations of different variables and the possible specification issues that could have resulted from poor correlations, the model was modified to produce more meaningful results. Specifically, RSA and SCL reactivity was analyzed separately in future models given the lack of correlation between the two constructs. It was also discovered that the interaction term between effortful control and physiological reactivity was detrimentally impacting the model fit to a large degree. As such, the interaction term was excluded from future analyses. The data were also subjected to the bootstrap technique (1,000 re-samples with replacement) when subsequent models were run to account for assumptions regarding the shape of the sampling distribution (Edwards & Lambert, 2007; Preacher et al, 2007). General correlations among the latent constructs can be seen on Table 3.

RSA Reactivity Models

The Figure 4.0 model was first tested using teacher report of externalizing behavior with all preceding modifications noted. Of note, the fourth RSA reactivity block residual variance was set to zero because of negative residual. This modification was made to all RSA models unless otherwise noted. The model converged with no errors and produced the following fit indices: χ^2 = 2,020.97 (*df*=203, *p*<0.00), RMSEA = 0.06, SRMR=0.05, CFI=0.84, and TLI=0.82. These figures suggest less than ideal model fit. As such, error covariations among single latent variable indicators as suggested by Mplus were included. Appropriate covariations were added according to theory. For example, APQ indicators' error variances were covaried because they are all predicted by parental involvement and are derived from the same measure. However, APQ indicator error variances were not covaried with the indicators of other latent variables. The residual variances of the positive affect and approach indicators were covaried as indicated by Mplus given that they are both indicators of temperamental traits. The modifications made can be seen in Figure 4.1 along with respective path coefficients. Detailed information for these regression coefficients can be seen in Table 4. Indicator estimates for this model are found in Table 5. Indices for this model demonstrated good model fit: χ^2 =1,264.24 (*df*=187, *p*<0.00), RMSEA = 0.05, SRMR=0.05, CFI=0.90, and TLI=0.89. Parameter estimates show that only negative affect significantly predicted parental involvement in partial support of hypothesis 4. Table 6 presents the McDonald's omega for the parameters in the model. McDonald's omega measures how well latent constructs load onto observed variables (McDonald, 1999; Zinbarg, Revelle, Yovel, & Li, 2005). Table 6 also presents R-square values for the predicted latent constructs. These values account for the combined variance in the latent construct that can be accounted for by its predictors.

The model presented in figure 4.0 was then tested using parent report of externalizing behavior. As with the teacher-report, the model converged with no errors and produced the following fit indices: χ^2 = 2,142.88 (*df*=203, *p*<0.01), RMSEA = 0.07, SRMR=0.06, CFI=0.84, and TLI=0.82. Similarly, this model also exhibited less than ideal fit. As was the case with teacher-report, residual covariances that were in line with theory were added as indicated by the modification indices. The modifications suggested and implemented were identical to that of the teacher model. The modifications and new regression coefficients can be seen in Figure 4.2. Indicator estimates and more detailed information on path coefficients can be seen on Tables 7 and 8. The modified model demonstrated good model fit: χ^2 =1,405.13 (*df*=187, *p*=0.00), RMSEA = 0.05, SRMR=0.05, CFI=0.90, and TLI=0.88. The parameters of this model demonstrate that RSA significantly predicted externalizing behavior where by higher RSA predicts higher levels of parent-reported problem behavior (hypothesis 2). An indirect path between externalizing behavior and negative affect through parental involvement (hypothesis 4) was also supported. The relationship between negative affect and parental involvement was consistent with the relationship found in the teacher-report model. Higher parental involvement, in turn, predicted lower levels of problem behavior. The relationship in the literature between effortful control and externalizing behavior was also supported. Higher levels of effortful control predicted lower levels of externalizing behavior. Lastly, a direct significant relationship between negative affect and externalizing behavior demonstrated that lower levels of negative affect predicted higher levels of problem behavior. Table 9 presents the McDonald's omega and R-square values for the parameters in the model.

SCL Reactivity Models

The SCL reactivity model on Figure 5.0 was first tested using teacher report of externalizing behavior. Of note, the fourth SCL reactivity block residual was set to zero because of a negative initial residual. It was set to zero for all other SCL models analyzed unless otherwise specified. The model converged with no errors and produced the following fit indices:

χ^2 = 2,024.95 (*df*=203, $p<0.01$), RMSEA = 0.06, SRMR=0.05, CFI=0.89, and TLI=0.88. Like the previous models, the initial fit was less than adequate and residual covariances were added and implemented as suggested by the modification indices and theory. The modified teacher-report model is depicted on Figure 5.1. The model converged with no errors and produced the following fit indices: χ^2 = 1,265.52 (*df*=187, $p<0.00$), RMSEA = 0.05, SRMR=0.05, CFI=0.94, and TLI=0.92. This model demonstrated good fit and demonstrated that negative affect significantly predicted SCL reactivity (hypothesis 1) and parental involvement (partial support of hypothesis 4). Lower negative affect predicted higher SCL reactivity. The relationship between negative affect and parental involvement was consistent with previous models. The model also a demonstrated a significant negative path between parental involvement and SCL reactivity indicating that lower levels parental involvement predict higher SCL reactivity. Specific information on indicator estimates and path coefficients is located in Tables 10 and 11. McDonald's omega and R-square values for this model can be found on Table 12.

The model in Figure 5 was then tested using parent report of externalizing behavior. This model also converged with no errors and produced the following fit indices: χ^2 = 2,122.17 (*df*=203, $p<0.00$), RMSEA = 0.07, SRMR=0.06, CFI=0.89, and TLI=0.88. This model demonstrated less than ideal fit and, as with the other models, was modified according to Mplus modification indices and theory. The modified model can be seen in Figure 5.2. This model showed good fit: χ^2 = 1,382.05 (*df*=187, $p<0.01$), RMSEA = 0.05, SRMR=0.05, CFI=0.93, and TLI=0.92. Indicator estimates and path coefficients can be found on Tables 13 and 14. All paths in the model were significant. The significant paths found in the previous teacher-report model were evident in this model. Lower SCL reactivity was also associated with higher levels of externalizing behavior (hypothesis 2). Paths relating effortful control and parental involvement to externalizing behavior were consistent with the RSA parent-report model. To assess the strength of each of these paths, McDonald's omega and R-square values for this model can be found on Table 15.

Analyses by Sex

Given that some research has demonstrated gender differences in externalizing behavior when considering temperament and emotion regulation, the models described above were analyzed by sex (Allen & Matthews, 1997; Beauchaine, Hong, & Marsh, 2008; Bowie, 2010; Graves, Blake, & Kim, 2012). However, prior to analyzing these models, basic correlation analyses were run to determine whether structural equation modeling analyses were warranted. The correlations for females using static and reactive physiological variables can be found on Tables 16 and 17, respectively. Identical correlations can be found for males on Tables 18 and 19. According to the correlation analyses, relationships were found that were unique to each gender. For females, some temperament indicators (fear and inhibitory control) were related to parent and teacher reported externalizing behavior. Parental involvement was also related to SCL static blocks as well as teacher-reported behavior. Lastly, RSA reactivity was related to parent-reported externalizing behavior for females only.

With regard to males, some temperament indicators (Shyness, Approach, and Positive Affect) were related to static indicators of SCL and RSA. Activity and approach indicators also related to parental involvement. Lastly, static indicators for RSA were inversely related as expected to static indicators of SCL. Given these notable differences in relationships among the variables between males and females, it was determined that analyses of the above models by sex were merited.

Structural Model Analysis

A factorial invariance method was used to determine whether differences by gender existed within each of the models previously analyzed. Using this method, measurement invariance must first be established by constraining the factor loadings and latent covariances for different groups in one model and freely estimated them in another. If there is not a significant difference in model fit (i.e. CFI difference less than or equal to 0.01), invariance has been established. After establishing measurement invariance an omnibus test across groups is conducted to assess for significant differences by groups within the models. The omnibus test requires the latent variance and covariances for the given model to be constrained to be equal in one analysis and freely estimated in another. This method creates a comparison of a constrained latent model relative to baseline model. If there a significant difference in fit, moderation by group is indicated. If moderation by group is indicated, parameters are systematically freed in the constrained model according to modification indices until there are no longer significant fit differences to the baseline model. Freed parameters are paths that are moderated by group in the model. For additional information on this method please refer to Cheung & Rensvold (2002), Meredith (1993), and Millsap and Meredith (2007).

Models Using Teacher Report of Externalizing Behavior

To establish measurement invariance the parameter of negative affect by positive affect had to be freed for all the weak invariance models examined unless otherwise specified. The analysis examining RSA demonstrated a χ^2 = 2,297.732 (df=370, p<0.00), RMSEA = 0.07, and CFI=0.847 for the configural model and a χ^2 = 2,452.105 (df=396, p<0.00), RMSEA = 0.07, and CFI=0.837 for the weak invariance model. The CFI difference of 0.01 indicates measurement invariance. When the baseline model was compared to a constrained model, the following differences were obtained: χ^2 =0.632, df=16, p > 0.999. These differences demonstrate that there are no significant differences between males and females for the model examining RSA when using teacher report of externalizing behavior.

The model examining SCL using teacher report of externalizing behavior demonstrated the following fit indices for the configural and weak invariance models when establishing measurement invariance: Configural χ^2 = 2,379.875 (*df*=370, *p*<0.00), RMSEA = 0.07, and CFI=0.888; Loading χ^2 = 2,556.812 (*df*=396, *p*<0.00), RMSEA = 0.07, and CFI=0.879. The CFI difference of 0.009 illustrates measurement invariance. When the constrained model was compared to a baseline model the following difference were obtained: χ^2 =11.55, *df*=16, *p* = 0.774. As with the model examining RSA, this model did not demonstrate any significant differences by gender.

Models Using Parent Report of Externalizing Behavior

The model examining RSA was first analyzed. The following fit was obtained for the configural and weak invariance models when establishing measurement invariance: Configural χ^2 = 2,318.080 (*df*=370, *p*<0.00), RMSEA = 0.07, and CFI=0.852; Loading χ^2 = 2,475.675 (*df*=396, *p*<0.00), RMSEA = 0.07, and CFI=0.842. The CFI difference of 0.01 illustrates measurement invariance. When a constrained model was compared to a baseline model, significant chi-square differences were obtained. As a result, regression parameters were systematically freed in the constrained model. All regression paths were eventually freed and the chi-square difference (χ^2 =31.70, *df*=13, *p* < 0.01) remained significant. This finding indicates that the parameters in this model are unequal across gender, which suggests gender moderation. However, because the constrained and baseline model difference remained significant after all parameters had been freed in the constrained model, the original model analyzed (RSA parent-report model using the entire sample) had to be run separately by gender (i.e. run with only males and then with only females) to determine the specific differences in regression paths. When these models were conducted they were poor fitting, and thus remained untenable (Males: χ^2 = 1,139.79 *df*=187, *p*<0.01, RMSEA = 0.06, SRMR=0.06, CFI=0.88, and TLI=0.85; Females: χ^2 = 1,204.09 *df*=187, *p*<0.01, RMSEA = 0.08, SRMR=0.07, CFI=0.80, and TLI=0.76).

The model examining SCL using parent report of behavior was then analyzed. The comparison of the configural and weak invariance models demonstrated measurement invariance (Configural χ^2 = 2,387.206 *df*=370, *p*<0.00, RMSEA = 0.07, and CFI=0.890; Loading χ^2 = 2,567.154(*df*=396, *p*<0.00, RMSEA = 0.07, and CFI=0.882; ΔCFI=0.08). Consistent with the model examining RSA, this model demonstrated a significant chi-square difference when constrained and baseline models were compared. As such, regression paths were systematically freed in the constrained model. After all parameters had been freed, the difference between the constrained and baseline models remained significant (χ^2 =43.84, *df*=9, $p < 0.01$). Like the RSA parent-report model, this finding indicates that the parameters were unequal across gender suggesting moderation by sex. Because the baseline and constrained model difference in chi-square remained significant after all parameters were freed, the original model needed to be analyzed separately for males and females to uncover specific differences. When analyzed separately, these models were also poor fitting and thus untenable (Males: χ^2 = 1,182.48 *df*=187, *p*<0.01, RMSEA = 0.06, SRMR=0.06, CFI=0.89, and TLI=0.88; Females: χ^2 = 1,234.92 *df*=187, *p*<0.01, RMSEA = 0.09, SRMR=0.07, CFI=0.87, and TLI=0.84). To summarize, SEM analyses by gender for the models using parent-report of behavior suggest that there is moderation by sex; however, specific differences cannot be obtained with the current data.

DISCUSSION

The purpose for this study was to examine the specific pathways among effortful control, negative affect, parental involvement, and autonomic nervous system functioning in relation to parent and teacher reported externalizing behavior. The findings of this study were meant to identify potential pathways that could be targeted in treatment to prevent the development of significant behavior problems. The results indeed demonstrate consistent patterns of relationships across models. The findings also show that problem behavior is likely a function of social context. This section will discuss the major findings for the study, elaborate on the implications of the results, and comment on how social context may have impacted the relationships uncovered.

Major Findings

Models Using Parent Report

Prior to describing the global findings for the models using parent-report of behavior, it is important to note that the findings for these models must be interpreted with caution. When these models were analyzed by sex, the results suggested that all pathways in the models were moderated by gender. However the study did not have sufficient power to clarify the nature of these gender effects. Despite this caveat, the models still demonstrated consistent and notable significant results.

RSA Reactivity Model

The results of the parent-report models add to the research by demonstrating that ANS reactivity predicts child behavior. Other significant findings extend prior research by demonstrating that the predicted relationships are applicable to an at-risk preadolescent population. The parent-report model analyzing RSA showed that higher RSA reactivity was associated with greater problem behavior. This is the first time that such a finding has been uncovered within the context of the other variables in an at-risk youth population. Related research with community samples indicates that autonomic cardiac markers are more accurate at capturing regulative activity compared to other parasympathetic markers (Beauchaine, 2009). Further, findings support the theoretical models presented by Porges and other researchers. When stressed, emotionally healthy individuals are thought to deploy their vagal system to suppress adverse emotional reactions characterized by the fight/flight responses through use of the vagal brake. In essence, vagal withdrawal during intense emotional experience allows for emotion regulation (Porges 1995, 2001). However, if the stressor is severe, this vagal system will function in a manner that prepares the body to produce the metabolic output necessary to deal with the stressor (fight/flight). If individuals have abnormally developed vagal regulative systems, they are unable to move past the emotional inhibition into the alerting stage. In other words, deficiencies in the "smart" vagus system force the individual to use the evolutionarily older vagal pathways. These deficiencies, marked by higher levels of RSA reactivity, cause the child to become emotionally labile and engage in more risk-taking behaviors (e.g. fights, fire setting, etc.; Porges 1995, 2001, 2005).

The RSA parent model also demonstrated that parental involvement mediated the relationship between negative affect and externalizing behavior. Although novel, this finding is supported theoretically. Past research has suggested that children's development of negative affect may negatively impact parental involvement. In younger children, those with less difficult affects and temperaments demonstrated higher levels of support and involvement from parents (Cook et al, 2009; Mesman 2009). With regard to behavior, Morris (2007) theorized that parents who are less involved in the lives of their children do not have as many opportunities to teach them coping strategies to deal with stressors. With fewer coping strategies, these children are not as resilient and may resort to aggression and other externalizing behaviors to cope with environmental stressors. The uncovered mediation suggests that parent involvement may be important when predicting a child's behavior in the home environment.

Two other relationships were also found in the model analyzing RSA reactivity. Consistent with the literature, higher effortful control predicted lower levels of externalizing behavior. Lower negative affectivity also predicted higher levels of parent-reported externalizing behavior. Although this finding may seem counterintuitive, it may be due to the constituent variables in the latent construct. Fear is one of the stronger observed variables for this latent construct. Research has shown that children low in fear exhibit higher levels of problem behavior because they tend to engage in higher risk-taking taking activities (Neumann, Hare, & Newman, 2007). Thus, children who exhibited lower levels of negative affect in this study are likely characterized by lower levels of fear, which in turn is predictive of increased behavior problems.

SCL Reactivity Model

The parent-report model analyzing SCL reactivity demonstrated relationships consistent with those found in the model examining RSA reactivity. It also uncovered significant relationships among SCL reactivity, negative affect, and parental involvement to parent report-reported externalizing behavior. The relationships among negative affect, parental involvement, and externalizing behavior were consistent with those found in the parent-reported RSA model. This model also showed that higher levels negative affect and parental involvement predict lower SCL reactivity as was expected. Lower SCL reactivity is linked to emotions of frustration and irritability in children during difficult tasks suggesting that lower reactivity is reflective of poor self-regulation (Bubier & Drabick, 2008). At-risk children in the current study demonstrated a similar pattern. The at-risk participants with greater negative affectivity exhibited lower SCL reactivity suggesting that they were having difficulty physiologically regulating themselves in the presence of frustrating stimuli. With regard to parental involvement, there is research suggesting that parental involvement serves as a mediator between self-regulation and a child's functioning (Bryan & Dix, 2010). When children are functioning poorly to the point where it is impacting their self-regulation, this research suggests that parents become more involved to support their children. In line with this research, this study demonstrated that parents became more involved when a child's physiological reactivity was suggestive of poor self-regulation.

This model adds to the literature by demonstrating that sympathetic reactivity predicted behavior. This finding suggests that children who exhibit greater externalizing symptoms are sympathetically maladapted. Prior research supports this assertion by demonstrating that children with comparable sympathetic presentations exhibit higher novelty seeking and impulsive behaviors (Glenn, et al, 2009; Lorber, 2004). Children are thought to engage in these behaviors because their sympathetic nervous system branch has developed a higher threshold to noxious stimuli before alerting the host of potential dangers or negative consequences. With higher thresholds, these children are likely to engage in more risky behaviors that may cause them harm (e.g. fights, verbal aggression, etc.). The higher sympathetic threshold is marked by lower sympathetic activation because these children require a greater level of stimulation before their physiological regulative functions become activated. Several studies and meta-analyses have supported this relationship by demonstrating that children with lower SCL and SCL reactivity exhibit higher rates of externalizing behavior and delinquency (Beauchaine, et al, 2001; Glenn, et al, 2009; Lorber, 2004; Posthumus et al, 2009). This finding extends prior research by demonstrating that the relationship between lower SCL reactivity and externalizing behavior is present in a sample of preadolescent youth at risk for aggression.

Models Using Teacher Report

The models using teacher report of behavior demonstrated a significant relationship between negative affect and parental involvement whereby greater negative affect predicts poorer involvement. This finding is in line with current research indicating that parents of children with difficult temperaments find it difficult to be involved in their children's lives because their mood is difficult to manage (Mesman, et al, 2009). The teacher-report model analyzing SCL reactivity also demonstrated relationships among negative affect, parental involvement, and SCL reactivity consistent to those of the parent model.

In light of the aforementioned findings, a striking difference in the pattern of relationships was noted according to the reporter of behavior. Behavior was predicted by the variables of study *only* when reported by parents. This suggests the causes and triggers for externalizing behavior in at-risk preadolescents may be different according to their social context (i.e. classroom vs. home). The differences in these contexts in relation to externalizing behavior will be discussed with consideration to the findings of the current study.

Social Context

Using teacher report, none of the variables of study significantly predicted behavior. Does this mean that these variables do not impact behavior at school, or are youth influenced by different triggers according to context? Aspects of the home and school environments will be discussed to explore the differences by reporter.

Home

The parent-child relationship, aggression between siblings, and the lack of a structured home were the strongest predictors of externalizing behavior in the home context according to a review of the literature (Bennett, Elliot, & Peters, 2005; Bowes et al, 2009; Hemphill & Littlefield, 2006; Lopez et al, 2001; Price, Chiapa, & Walsh, 2013). The findings of the current study provide support for the role of the parent-child relationship. A positive parent-child relationship is in part characterized by positive parental involvement (Barnett, Elliot, & Peters, 2005). In the current study, parental involvement significantly mediated the impact of a child's negative mood on problematic behavior suggesting that a positive parent-child relationship allows for better regulation of a child's affect and a reduction in problem behavior. Children with positive parental involvement and interactions, for example, develop more efficient techniques and strategies to cope with conflicts and stressors (Hardy, Power & Jaedicke, 1999). Samples of children with more positive parent-child relationships were also linked with better temperaments and emotion regulation (Akker, et al, 2010; Karreman, et al, 2009). Although noteworthy, parents are not the sole contributors to child behavior. In light of the current findings and past research, other factors also show a significant influence on externalizing behavior within the home context.

Physiological reactivity directly predicted parent-reported behavior. Results indicated that autonomic under-arousal predicted externalizing problems. This finding suggests that children at-risk for externalizing behavior are not reacting appropriately to threats or stressors within the home environment. With respect to past research, aggression between siblings was also found to predict externalizing behavior. In consideration of these two findings, sibling aggression may be a function of poor physiological self-regulation. Past research showed that SCL reactivity moderated the relationship between stressful peer experiences/victimization and parent-reported externalizing behavior (Gregson, Tu, & Erath, 2014). Youth with better sympathetic regulation were more effectively able to manage hostile peers and exhibit better parent-reported behavior. Thus, the current study provides further evidence for the possible role of autonomic self-regulation when addressing problem behaviors within the home context.

The perceived structure of the home was the last factor noted to predict parent-reported behavior according to a review of the research. A youth's perception of the home structure is characterized by his or her social interactions within the home (Price, Chiapa, & Walsh, 2013). This means that a child's perception of structure is based on the nature of the relationships to his or her parents and siblings. Therefore, the link between perceived home structure and behavior may lie in the parent-child relationship and the child's ability to physiologically self-regulate given the possible aforementioned relationships among parental involvement, sibling relationships, and behavior. Based on the current findings and their associations to prior research, future studies examining the home context and problem behavior should consider analyzing the roles of physiological self-regulation and parental involvement as well as personal characteristics that could contribute to behavior (i.e. temperamental traits). It is important to note that the paths in all the parent-reported models were moderated by gender, but specific effects could not be determined. Therefore, future research should also examine for gender effects among the variables of study.

School

None of the variables analyzed significantly predicted behavior using teacher-report. This finding suggests that different variables may trigger disruptive behavior in the classroom setting. Different variables may also override the impact of the variables of study within the classroom. According to a review of the literature the student-teacher relationship, classroom structure, and peer relationships all significantly predict problem behavior at school (Bennett, Elliott, & Peters, 2005; Bowes, et al, 2009; Brown-Wright et al, 2013; Cothran, Kulinna, & Gurrahy, 2009; Lopez, et al, 2001; Stromshak, Bierman, & CPPRG, 1998). The possible impact of these variables when predicting behavior in relation to the variables of study will be discussed.

Research analyzing the student-teacher relationship demonstrated that a poor relationship predicts aggression, defiance, and other behavior problems (Bennett, Elliott, & Peters, 2005; Brown-Wright et al, 2013; Tyler et al, 2010). These studies explained that students' perception of their teachers may be a contributor to problem behavior. If students feel rejected or devalued by their teachers they may be more likely to exhibit problematic behavior to express their frustration with the student-teacher relationship (Brown-Wright, et al, 2013; Tyler, et al, 2010). Some research supports the notion that disruptive behavior may be used as a coping strategy for students who feel shunned by their academic setting (Bennett, Elliot, & Peters, 2005). However, given past research, the teacher relationship is likely only one among many factors that contributes to externalizing behavior within the classroom.

Prior research showed that the classroom environment predicted problem behavior. Specifically, classroom structure, class size, classroom resources, level of stimulation, and perception of a positive learning environment all predicted externalizing behavior at school (Bowes, et al, 2009; Bennett, Elliott, & Peters, 2005; Cothran, Kulinna, & Gurrahy, 2009; Lopez, et al, 2001; Smith & Carlson, 1997). Higher levels of structure and stimulation were associated with fewer behavior problems. The causes for these relationships may lie in student perceptions. Students in highly structured classrooms may feel more guarded expressing emotion when compared to a more unstructured home context. Thus, emotionality may not be as significant a predictor of behavior in school when compared to the home as observed by teachers. Similarly, classrooms with higher levels of stimulation and more resources may provide students with fewer opportunities to engage in problematic behavior because these students may spend more time engaged in lessons. The structure and organization of the classroom may therefore limit the social conflicts that children participate in; which in turn, limits their opportunities to engage physiological self-regulation.

Peer relationships may also factor into the prediction of behavior. Research has shown that peer relationships are important predictors of behavior in the classroom (Cothran, Kulinna, & Gurrahy, 2009; Lopez, et al, 2001; Stromshak, Bierman, & CPPRG, 1998). However, it is difficult to determine how peer relationships in the classroom differ from peer relationships in the home or neighborhood. At school, students have larger peer groups than they do at home or neighborhood. Increased social pressures due to an increased peer group may override a child's ability to self-regulate within the school context. Some studies suggest that when environmental demands exceed a child's ability to physiologically self-regulate, the child may become emotionally labile and engage in externalizing behavior (Hartman et al, 2013; Porges, 1991, 2001, 2005). Thus, a larger peer group in association with increased social demands may be the link to externalizing behavior for poorly regulated individuals at school. Future research should consider this possibility given the dearth of studies comparing home and school peer groups. Prior research does show that students who feel rejected by their peers or who perceive their peers as hostile are more likely to engage in aggression and other externalizing behaviors (Cothran, Kulinna, & Gurrahy, 2009; Lopez, et al, 2001; Stromshak, Bierman, & CPPRG, 1998). This research asserts that externalizing behavior is used to gain social status within these peer groups. This assertion implies that a youth's social environment at school may take precedence over his or her ability to physiologically self-regulate. Given the differences in reported behavior found in the current study, future studies should examine peer groups and the other school-variables addressed when analyzing externalizing behavior across social contexts.

Other Factors to Consider

According to some research, there is poor diagnostic agreement between parents and teachers (Connolly & Vance, 2010). Other studies state that the parent-teacher congruence on behavior, emotional problems, and traits increases when examining 6-11 year-old children versus adolescents (Achenbach et al, 1987; Dinnebeil et al, 2007; Renk & Phares, 2004). These findings suggest that when gathering information from caregivers, research with younger children may be more accurate. Regardless, the low correspondence between teachers and parents indicates that they may be focusing on different behaviors.

Some research shows that parents and teachers tend to focus on different yet valid behaviors. Parents are thought to focus on daily and irritating behaviors while teachers focus on a smaller number of more severe behaviors (Bank, et al, 1993). This finding implies that the frequency with which parents and teachers report behaviors may differ. If teachers are focusing on more severe behaviors, the frequency of behaviors reported is likely to be lower than that of parents because their threshold for what is problematic is higher. If so, externalizing behavior is only reported for the most severe children. This teacher underreporting may have resulted in the inaccurate assessment of teacher-rated participant behavior. A study by Epkins (1996) supports this notion by showing that for 8-12 year-old children, the correspondence on aggression between parents and teachers was better for outpatient versus inpatient children. This finding suggests that there is better agreement on behavior between parents and teachers for children with less severe behavior problems.

The literature has also demonstrated that other children in the environment may influence what is considered normative behavior. Studies have indicated that teacher ratings of behavior are not independent of other children, but rather focus on the comparison to other students in the classroom (Hamre, Pianta, Downer, & Mashburn, 2007; Hartman, Rhee, Willcutt, & Pennington, 2007; Phillips & Lonigan, 2010; Dinnebeil et al, 2013). Dinnebeil and colleagues (2013) supplemented this research with a finding indicating that 29.2% of the variance in teacher behavior ratings was due to the rating of multiple peers. The literature shows that parents compare their children as well. Hartman, Rhee, Wilcutt, & Pennington (2007) showed that when reporting problem behaviors, parents tended to compare and contrast their twin children. These findings posit that parent and teacher reports of behavior may be partial to the presence of peers and a focus on different types of behavior. Thus, future studies should collect and account for family and peer data when analyzing child behavior.

Of note, failure to predict behavior in the teacher-reported models may have been due to the nature of the sample. At-risk populations may limit the range of behaviors that teachers observe. In turn, a restricted range of behaviors limits the statistical possibility of finding significant relationships between the predictor variables and reported behavior. Future research may also want to account for possible psychopathic traits. Research has shown there is a large overlap between psychopathic traits and the diagnostic symptoms of conduct disorder (CD), ADHD, and oppositional defiant disorder (ODD; APA, 2000; Da Silva, Rijo, & Salekin, 2013). Some studies also show that youth with psychopathic traits exhibit similar physiological responses to stressors as did the participants of the current study (Benning et al, 2005; Flor et al, 2002; Gao Raine, & Schug, 2012; Patrick, Bradley, & Lang, 1993; Wang Baker, Gao, Raine &

Lozano, 2012). Distinguishing youth with and without psychopathic traits in future research will help better conceptualize the development of problem behavior in each of these groups.

Limitations

This study presents novel findings that will aid in better conceptualizing the development of externalizing behavior in youth at risk for aggression. However, the results should be interpreted within the contexts with which they were derived. The first major limitation of this study is the use of cross-sectional (baseline) data. Analysis of cross-sectional data inhibits the ability to establish temporal directionality, and thus, causality. As is, the data only allow the researcher to establish meaningful associations among the variables. If longitudinal data were collected, causal links could be inferred and tested. The second limitation is use of a homogenous sample. Recruitment for this study resulted in a largely African American, male, low-middle SES population from central Alabama. Given the specificity of the sample, the results cannot be generalized to all youth at risk for aggression. However, the findings for this exploratory study provide solid grounding for the kinds of results that may be expected from future studies with more diverse populations.

The study's third significant limitation is the use of the EAT-Q scales for the derivation of the negative affect and effortful control constructs. These scales ranged from poor to acceptable internal consistency (Chronbach's alpha), with many of the scales hovering near 0.5. Future studies should take note of this finding given the scales' general support in the literature. Fourth, the mediation findings using parent-report of externalizing behavior may be subject to source bias. In these models, parent report was used for the EAT-Q scales, the APQ, and the BASC-II. Use of the same reporter may have increased the likelihood of finding significant results. However, each path in the mediation is firmly supported in the literature.

The final limitation of note is that of power and sample size. Given their complexity, the structural models analyzed required large sample sizes for adequate power. Lack of sufficient power also limited the analysis of gender effects. To combat this problem, data was multiply imputed and bootstrapped.

Conclusion

This study provided a novel perspective on the development of externalizing behavior in youth at risk for aggression. The findings for this study allow for comparison to normative samples and replication in future studies. These comparisons will aid in the accurate assessment of risk factors for externalizing behavior.

This study also highlights the roles of autonomic nervous system functioning and parental involvement when predicting externalizing behavior within the home context. The findings for this study may have important implications for the development of prevention interventions. The global parent models indicate that management of arousal should be considered for both children and parents. Sympathetic and parasympathetic functioning in the current study suggested that at-risk preadolescents are maladaptively regulated. Higher RSA reactivity indicated that at-risk youth experience reductions in vagal withdrawal. This reduction consequently negates sympathetic activation. Increased externalizing problems were thought to result because autonomic functioning prevented youth from accurate risk assessment when engaged in stressful situations. Teaching these children strategies to make them more aware of potentially dangerous or harmful situations may help make up for their autonomic dysregulation. Empirically supported interventions that teach children emotional awareness in themselves and others have already shown efficacy in reducing reactive and proactive aggression (Lochman, et al, 2011, 2012). These interventions also focus on teaching children to better recognize threatening and non-threatening situations.

Having parents learn to manage their own emotions in response to children's negative affect may also improve child behavior. Appropriate management of parental emotion may increase their involvement in their children's lives resulting in improved child behavior. Research with pre-K children indicated that parents who perceived their children as more emotionally intense also reported higher levels of stress, which in turn decreased their level of involvement (McBride, Schoppe, & Rane, 2002). This finding implies that helping parents learn how to regulate their own emotions and stress levels in response to difficult children will likely improve their involvement. Increased involvement, as prior research firmly supports, will improve child behavior. In essence, the current study suggests that within the home environment, interventions should consider the parallel processes of child and parent arousal/emotional regulation to reduce externalizing behavior.

A third strength of this study was the collection of data from multiple reporters allowing for analysis of externalizing behavior in different environments. This provided a unique look into how the predictor variables manifest themselves under different contexts. The findings indicated that there are notable differences by reporter in externalizing behavior. This suggests that more so than just the variables of study, interaction of these and other variables within specific social contexts may be predictive of behavior. This finding indicates that the prevention of problem behavior needs to be addressed differently according to social context. In the school setting, for example, behavior may be more reflective of the teacher-student relationship or other school-specific variables. In line with the differences by reporter, the results also indicated that the relationships among the variables only varied by gender when using parent-report of behavior.

This result reveals that the variables of study function differently between males and females according to factors within the home social context. It is recommended that future research delve further into these relationships by gender to uncover their specific directions.

Overall this study highlighted novel relationships among the variables of study that will serve to contribute to the future treatment and prevention of externalizing behavior in at-risk youth. The study also served to illustrate important differences by sex and social context that future research should address to be able to customize treatment to the needs of at-risk youth. Lastly, confidence in the results of this study can be placed in the well fitting global structural models. Effect sizes were modest, but significant, and all models analyzed were consistent by reporter.

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Table 1

Correlations Among Variables, Means, & Standard Deviations

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1. Shyness	-																
2. Positive Affect	-0.28**	-															
3. Fear	0.08	0.28**	-														
4. Inhibitory Control	-0.1	0.20**	0.01	-													
5. Approach	0.20**	0.49**	-0.23**	-0.05	-												
6. Activity	0.19**	0.67**	-0.28**	-0.21**	0.39**	-											
7. Parental Involvement	-0.07	0.13*	0.12*	0.06	-0.24**	-0.16**	-										
8. Baseline RSA	-0.08	0.06	-0.04	0.06	-0.08	0.01	0.01	-									
9. Block 3 RSA	-0.08	0.03	-0.03	0.01	-0.09	0.03	0.05	0.88**	-								
10. Block 4 RSA	-0.09	0.06	-0.01	-0.01	-0.11	0.02	0.05	0.86**	0.96**	-							
11. Block 5 RSA	-0.06	0.06	0.01	-0.03	-0.07	0.04	0.06	0.85**	0.93**	0.95**	-						
12. Baseline SCL	0.07	-0.03	0.06	-0.01	-0.16*	0.03	-0.07	-0.09	-0.07	-0.08	-0.05	-					
13. Block 3 SCL	0.12	0.04	-0.01	0.02	0.15*	-0.02	-0.15*	-0.11	-0.13*	-0.13	-0.10	0.48**	-				
14. Block 4 SCL	0.10	0.07	0.03	0.01	0.12	-0.05	-0.11	-0.13*	-0.15*	-0.14*	-0.11	0.46**	0.98**	-			
15. Block 5 SCL	0.11	0.04	0.03	0.02	0.13	-0.04	-0.10	-0.15*	-0.16*	-0.15*	-0.12	0.44**	0.94**	0.98**	-		
16. Prnt Externalizing	0.03	0.11*	0.06	-0.16**	-0.12**	-0.03	-0.14**	-0.05	0.02	0.04	0.03	0.12	0.08	0.07	0.06	-	
17. Tchr Externalizing	-0.05	0.12*	-0.13*	-0.01	-0.04	-0.12*	0.03	0.06	0.06	0.06	0.05	-0.01	0.02	0.03	0.05	.29**	-
Mean	2.85	2.81	2.81	2.75	3.15	3.48	3.95	7.45	7.49	7.47	7.45	7.93	10.38	10.92	11.53	29.16	41.04
Standard Deviation	0.64	1.18	0.68	0.71	0.90	0.71	0.54	1.07	1.01	0.97	0.98	6.90	6.68	6.89	7.16	14.30	17.51

* $p < .05$. ** $p < .01$

Table 2

Correlations Among Study Variables with Physiological Reactivity Variables

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Shyness	-														
2. Positive Affect	-0.28**	-													
3. Fear	0.08	0.28**	-												
4. Inhibitory Control	-0.10	0.20**	0.01	-											
5. Approach	-0.20**	0.49**	0.23**	0.05	-										
6. Activity	-0.19**	0.67**	0.28**	0.21**	0.39**	-									
7. Parental Involvement	-0.07	0.13*	0.12*	0.06	0.24**	0.16**	-								
8. RSA Rx3	0.01	-0.05	0.01	-0.12	<0.01	0.04	0.06	-							
9. RSA Rx4	0.01	-0.01	0.03	-0.15*	-0.04	0.04	0.06	0.85**	-						
10. RSA Rx5	0.06	-0.01	0.07	-0.16*	0.04	0.08	0.07	0.76**	0.82**	-					
11. SCL Rx3	0.04	0.07	-0.06	0.02	-0.02	-0.05	-0.06	-0.04	-0.02	-0.02	-				
12. SCL Rx4	0.03	0.09	-0.03	0.02	-0.04	-0.08	-0.03	-0.05	-0.02	-0.03	0.98**	-			
13. SCL Rx5	0.04	0.06	-0.02	0.03	-0.03	-0.07	-0.02	-0.04	<-0.01	-0.01	0.95**	0.98**	-		
14. Prnt Externalizing	0.03	0.11*	0.06	-0.16**	-0.12**	-0.03	-0.14**	0.15*	0.20**	0.15*	-0.05	-0.05	-0.05	-	
15. Tchr Externalizing	-0.05	0.12*	-0.13*	-0.01	-0.04	-0.12*	0.03	<0.01	-0.01	-0.03	0.02	0.04	0.05	0.29**	-
Mean	2.85	2.81	2.81	2.75	3.15	3.48	3.95	0.04	0.01	-0.01	2.45	3.00	3.61	29.16	41.04
Standard Deviation	0.64	1.18	0.68	0.71	0.90	0.71	0.54	0.51	0.54	0.56	6.91	7.19	7.44	14.30	17.51

* $p < .05$. ** $p < .01$

Table 3

Correlations Among Latent Variables

Variable	1	2	3	4	5	6	7
1.Parental Involvement	-						
2. Negative Affect	-0.23	-					
3. Effortful Control	0.21	-0.89	-				
4. RSA	0.01	-0.01	0.01	-			
5. SCL	-0.01	-0.08	0.07	-	-		
6. Prnt Externalizing	-0.19	-0.09	-0.02	0.10	-0.05	-	
7. Tchr Externalizing	0.01	-0.07	0.10	<0.01	0.03	-	-

Table 4

Parameter Estimates: RSA Teacher Model

Effect	Estimate	Beta	SE	*z*	*p*
RSA on					
Negative Affect	-0.005	-0.005	0.025	-0.183	0.855
Parental Involvement	<0.001	<0.001	0.025	0.009	0.993
Parental Involvement on					
Negative Affect	-0.239	-0.233	0.028	-8.648	<0.01**
Externalizing Problems on					
RSA	-0.008	-0.008	0.023	-0.339	0.734
Parental Involvement	-0.005	-0.005	0.026	-0.201	0.840
Effortful Control	0.190	0.189	0.100	1.909	0.056
Negative Affect	0.095	0.095	0.109	0.874	0.382
Indirect Effects					
Negative Affect→Involvement→Externalizing Problems	0.001	0.001	0.006	0.207	0.836
Negative Affect→RSA→Externalizing Problems	<.001	<.001	<.001	0.163	0.871

* p < .05. ** p < .01

Table 5

Indicator Estimates: RSA Teacher Model

Variable	Estimate	SE	*p*
Parental Involvement			
APQ1	0.446	0.018	<0.01**
APQ4	0.599	0.023	<0.01**
APQ7	0.487	0.019	<0.01**
APQ9	0.348	0.017	<0.01**
APQ11	0.334	0.024	<0.01**
APQ14	0.622	0.021	<0.01**
APQ15	0.472	0.027	<0.01**
APQ20	0.577	0.021	<0.01**
APQ23	0.374	0.020	<0.01**
APQ26	0.349	0.024	<0.01**
Negative Affect			
Shyness	0.140	0.016	<0.01**
Fear	-0.219	0.016	<0.01**
Positive Affect	0.879	0.031	<0.01**
Effortful Control			
Approach	0.276	0.015	<0.01**
Inhibitory Control	0.146	0.015	<0.01**
Activity	0.903	0.014	<0.01**
RSA			
RSA Rx3	-0.746	0.027	<0.01**
RSA Rx4	1.070	0.017	<0.01**
RSA Rx5	0.145	0.014	<0.01**
Externalizing Problems			
Aggression	7.803	0.154	<0.01**
Conduct Problems	2.621	0.072	<0.01**
Hyperactivity	5.864	0.157	<0.01**

* p < .05. ** p < .01

Table 6

McDonald's Omega & R^2 values for RSA Teacher Model

Latent Constructs By Indicators	ω
Parental Involvement	0.886
Negative Affect	0.822
Effortful Control	0.975
RSA	0.791
Externalizing Behavior	0.998
Predicted Latent Constructs	R^2
Parental Involvement	0.054
RSA	<0.001
Externalizing Behavior	0.013

Table 7

Parameter Estimates: RSA Parent Model

Effect	Estimate	Beta	SE	*z*	*p*
RSA on					
Negative Affect	-0.004	-0.004	0.025	-0.174	0.862
Parental Involvement	<0.001	<0.001	0.025	0.011	0.992
Parental Involvement on					
Negative Affect	-0.238	-0.232	0.028	-8.61	<0.01**
Externalizing Problems on					
RSA	0.102	0.098	0.024	4.188	<0.01**
Parental Involvement	-0.228	-0.225	0.028	-8.095	<0.01**
Effortful Control	-0.288	-0.276	0.128	-2.255	0.024*
Negative Affect	-0.401	-0.385	0.136	-2.940	0.002**
Indirect Effects					
Negative Affect→Involvement→Externalizing Problems	0.054	0.052	0.009	5.799	<0.01**
Negative Affect→RSA→Externalizing Problems	<0.001	<0.001	0.003	-0.174	0.862

* p < .05. ** p < .01

Table 8

Indicator Estimates: RSA Parent Model

Variable	Estimate	SE	*p*
Parental Involvement			
APQ1	0.455	0.018	<0.01**
APQ4	0.600	0.022	<0.01**
APQ7	0.483	0.019	<0.01**
APQ9	0.353	0.017	<0.01**
APQ11	0.334	0.024	<0.01**
APQ14	0.616	0.021	<0.01**
APQ15	0.476	0.027	<0.01**
APQ20	0.573	0.021	<0.01**
APQ23	0.379	0.020	<0.01**
APQ26	0.345	0.024	<0.01**
Negative Affect			
Shyness	0.138	0.016	<0.01**
Fear	-0.220	0.016	<0.01**
Positive Affect	0.882	0.031	<0.01**
Effortful Control			
Approach	0.276	0.015	<0.01**
Inhibitory Control	0.146	0.015	<0.01**
Activity	0.903	0.014	<0.01**
RSA			
RSA Rx3	-0.746	0.027	<0.01**
RSA Rx4	1.070	0.017	<0.01**
RSA Rx5	0.145	0.014	<0.01**
Externalizing Problems			
Aggression	5.042	0.111	<0.01**
Conduct Problems	3.396	0.083	<0.01**
Hyperactivity	4.344	0.115	<0.01**

* p < .05. ** p < .01

Table 9

McDonald's Omega & R^2 values for RSA Parent Model

Latent Constructs By Indicators	ω
Parental Involvement	0.932
Negative Affect	0.821
Effortful Control	0.976
RSA	0.985
Externalizing Behavior	0.998
Predicted Latent Constructs	R^2
Parental Involvement	0.054
RSA	<0.001
Externalizing Behavior	0.081

Table 10

Parameter Estimates: SCL Teacher Model

Effect	Estimate	Beta	SE	*z*	*p*
SCL on					
Negative Affect	-0.098	-0.098	0.025	-3.899	<0.01**
Parental Involvement	-0.078	-0.079	0.025	-3.056	0.002**
Parental Involvement on					
Negative Affect	-0.240	-0.234	0.028	-8.669	<0.01**
Externalizing Problems on					
RSA	0.020	0.020	0.023	0.887	0.375
Parental Involvement	-0.004	-0.004	0.026	-0.151	0.880
Effortful Control	0.188	0.187	0.098	1.917	0.055
Negative Affect	0.095	0.094	0.108	0.879	0.379
Indirect Effects					
Negative Affect→Involvement→Externalizing Problems	0.001	0.001	0.006	0.151	0.880
Negative Affect→RSA→Externalizing Problems	-0.002	-0.002	0.002	-0.862	0.389

* p < .05. ** p < .01

Table 11

Indicator Estimates: SCL Teacher Model

Variable	Estimate	SE	*p*
Parental Involvement			
APQ1	0.444	0.018	<0.01**
APQ4	0.598	0.023	<0.01**
APQ7	0.487	0.019	<0.01**
APQ9	0.348	0.017	<0.01**
APQ11	0.332	0.024	<0.01**
APQ14	0.624	0.021	<0.01**
APQ15	0.472	0.027	<0.01**
APQ20	0.578	0.021	<0.01**
APQ23	0.373	0.02	<0.01**
APQ26	0.348	0.024	<0.01**
Negative Affect			
Shyness	0.14	0.016	<0.01**
Fear	-0.219	0.016	<0.01**
Positive Affect	0.881	0.031	<0.01**
Effortful Control			
Approach	0.276	0.015	<0.01**
Inhibitory Control	0.146	0.015	<0.01**
Activity	0.903	0.014	<0.01**
SCL			
SCL Rx3	5.948	0.12	<0.01**
SCL Rx4	6.555	0.103	<0.01**
SCL Rx5	6.248	0.119	<0.01**
Externalizing Problems			
Aggression	7.798	0.154	<0.01**
Conduct Problems	2.622	0.072	<0.01**
Hyperactivity	5.865	0.157	<0.01**

* p < .05. ** p < .01

Table 12

McDonald's Omega & R^2 values for SCL Teacher Model

Latent Constructs By Indicators	ω
Parental Involvement	0.885
Negative Affect	0.823
Effortful Control	0.976
SCL	0.999
Externalizing Behavior	0.998
Predicted Latent Constructs	R^2
Parental Involvement	0.055
SCL	0.012
Externalizing Behavior	0.013

Table 13

Parameter Estimates: SCL Parent Model

Effect	Estimate	Beta	SE	*z*	*p*
SCL on					
Negative Affect	-0.099	-0.098	0.025	-3.904	<0.01**
Parental Involvement	-0.076	-0.078	0.025	-3.009	0.003**
Parental Involvement on					
Negative Affect	-0.239	-0.233	0.028	-8.623	<0.01**
Externalizing Problems on					
RSA	-0.075	-0.073	0.024	-3.088	0.002**
Parental Involvement	-0.233	-0.230	0.028	-8.219	<0.01**
Effortful Control	-0.288	-0.277	0.126	-2.293	0.022*
Negative Affect	-0.410	-0.394	0.135	-3.042	0.002**
Indirect Effects					
Negative Affect→Involvement→Externalizing Problems	0.056	0.054	0.010	5.846	<0.01**
Negative Affect→RSA→Externalizing Problems	0.007	0.007	0.003	2.334	0.020*

* p < .05. ** p < .01

Table 14

Indicator Estimates: SCL Parent Model

Variable	Estimate	SE	*p*
Parental Involvement			
APQ1	0.454	0.018	<0.01**
APQ4	0.599	0.022	<0.01**
APQ7	0.482	0.019	<0.01**
APQ9	0.353	0.017	<0.01**
APQ11	0.332	0.024	<0.01**
APQ14	0.618	0.021	<0.01**
APQ15	0.477	0.027	<0.01**
APQ20	0.574	0.021	<0.01**
APQ23	0.378	0.020	<0.01**
APQ26	0.343	0.024	<0.01**
Negative Affect			
Shyness	0.138	0.016	<0.01**
Fear	-0.220	0.016	<0.01**
Positive Affect	0.884	0.031	<0.01**
Effortful Control			
Approach	0.276	0.015	<0.01**
Inhibitory Control	0.146	0.015	<0.01**
Activity	0.903	0.014	<0.01**
SCL			
SCL Rx3	5.949	0.120	<0.01**
SCL Rx4	6.556	0.103	<0.01**
SCL Rx5	6.249	0.119	<0.01**
Externalizing Problems			
Aggression	5.050	0.112	<0.01**
Conduct Problems	3.405	0.083	<0.01**
Hyperactivity	4.356	0.115	<0.01**

* $p < .05$. ** $p < .01$

Table 15

McDonald's Omega & R^2 values for SCL Parent Model

Latent Constructs By Indicators	ω
Parental Involvement	0.931
Negative Affect	0.822
Effortful Control	0.976
SCL	0.999
Externalizing Behavior	0.998
Predicted Latent Constructs	R^2
Parental Involvement	0.054
SCL	0.012
Externalizing Behavior	0.077

Table 16

Correlations Among Variables for Females

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1. Shyness	-																
2. Positive Affect	-0.43**	-															
3. Fear	0.07	0.32**	-														
4. Inhibitory Control	-0.14	0.25**	0.01	-													
5. Approach	0.33**	-0.53**	-0.29**	-0.10	-												
6. Activity	0.28**	-0.67**	-0.36**	-0.12	0.45**	-											
7. Parental Involvement	-0.13	0.12	0.14	0.06	-0.21**	-0.06	-										
8. Baseline RSA	-0.12	-0.14	-0.13	0.10	0.04	0.07	0.01	-									
9. Block 3 RSA	-0.09	-0.12	-0.09	0.05	0.12	0.12	-0.07	0.89**	-								
10. Block 4 RSA	-0.15	-0.07	-0.05	0.05	0.06	0.10	-0.04	0.88**	0.95**	-							
11. Block 5 RSA	-0.13	-0.05	-0.03	0.00	0.07	0.13	-0.01	0.85**	0.91**	0.95**	-						
12. Baseline SCL	-0.05	0.00	0.05	-0.10	0.08	0.07	-0.20	-0.01	0.03	0.02	0.06	-					
13. Block 3 SCL	-0.07	0.06	-0.10	-0.06	0.02	0.00	-0.32**	0.01	-0.01	0.01	0.00	0.34**	-				
14. Block 4 SCL	-0.08	0.07	-0.09	-0.05	-0.01	-0.01	-0.33**	0.00	-0.03	0.00	-0.02	0.31**	0.98**	-			
15. Block 5 SCL	-0.08	0.02	-0.09	-0.06	0.01	0.00	-0.32**	0.00	-0.05	-0.02	-0.03	0.27*	0.94**	0.98**	-		
16. Prnt Externalizing	-0.03	0.11	0.02	-0.23*	-0.14	0.00	-0.19*	0.02	0.13	0.17	0.20	0.25*	0.16	0.16	0.09	-	
17. Tchr Externalizing	-0.08	0.10	-0.22*	-0.14	-0.06	-0.06	0.06	0.00	0.03	-0.04	-0.07	0.04	0.06	0.10	0.10	0.34**	-

* $p < .05$. ** $p < .01$

Table 17

Correlations Among Study Variables and Physiological Reactivity Variables for Females

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. RSA Rx3	-														
2. RSA Rx4	0.77**	-													
3. RSA Rx5	0.68**	0.86**	-												
4. SCL Rx3	-0.12	-0.05	-0.14	-											
5. SCL Rx4	-0.14	-0.06	-0.15	0.99**	-										
6. SCL Rx5	-0.16	-0.08	-0.17	0.97**	0.99**	-									
7. Shyness	0.06	-0.02	0.00	0.00	0.00		-								
8. Positive Affect	0.05	0.16	0.18	0.03	0.04	0.01	-0.43**	-							
9. Fear	0.10	0.18	0.20	-0.12	-0.11	-0.11	0.07	0.32**	-						
10. Inhibitory Control	-0.10	-0.11	-0.18	0.06	0.06	0.06	-0.14	0.25**	0.01	-					
11. Approach	0.17	0.03	0.06	-0.07	-0.08	-0.07	0.33**	-0.53**	-0.29**	-0.10	-				
12. Activity	0.09	0.03	0.09	-0.08	-0.08	-0.07	0.28**	-0.67**	-0.36**	-0.12	0.45**	-			
13. Parental Involvement	-0.16	-0.08	-0.03	0.00	-0.01	-0.01	-0.13	0.12	0.14	0.06	-0.21**	-0.06	-		
14. Prnt Externalizing	0.24*	0.27*	0.31**	-0.15	-0.14	-0.18	-0.03	0.11	0.02	-0.23*	-0.14	0.00	-0.19*	-	
15. Tchr Externalizing	0.07	-0.07	-0.12	0.00	0.02	0.02	-0.08	0.10	-0.22*	-0.14	-0.06	-0.06	0.06	0.34**	-

* *p* < .05. ** *p* < .01

Table 18

Correlations Among Variables for Males

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1. Shyness	-																
2. Positive Affect	-0.18**	-															
3. Fear	0.09	0.25**	-														
4. Inhibitory Control	-0.07	0.17*	0.01	-													
5. Approach	0.11	-0.47**	-0.19*	-0.03	-												
6. Activity	0.14*	-0.67**	-0.23**	-0.26**	0.35**	-											
7. Parental Involvement	-0.03	0.13	0.10	0.07	-0.26**	-0.22**	-										
8. Baseline RSA	-0.06	0.17*	0.02	0.05	-0.15	-0.03	0.00	-									
9. Block 3 RSA	-0.07	0.13	0.01	-0.01	-0.21*	-0.02	0.09	0.88**	-								
10. Block 4 RSA	-0.05	0.14	0.01	-0.05	-0.21*	-0.02	0.08	0.87**	0.97**	-							
11. Block 5 RSA	-0.02	0.13	0.03	-0.04	-0.15	0.00	0.08	0.85**	0.94**	0.94**	-						
12. Baseline SCL	0.21**	-0.06	0.07	0.09	0.24**	-0.01	0.01	-0.16	-0.21*	-0.20*	-0.19*	-					
13. Block 3 SCL	0.22**	0.04	0.04	0.06	0.22**	-0.02	-0.06	-0.19*	-0.23*	-0.22*	-0.19*	0.55**	-				
14. Block 4 SCL	0.20*	0.06	0.08	0.04	0.20**	-0.07	-0.02	-0.20*	-0.24*	-0.23*	-0.20*	0.53**	0.98**	-			
15. Block 5 SCL	0.21**	0.05	0.09	0.06	0.19*	-0.06	-0.01	-0.21*	-0.23*	-0.22*	-0.18*	0.53**	0.95**	0.98**	-		
16. Prnt Externalizing	0.05	0.11	0.09	-0.13	-0.23**	-0.04	-0.10	-0.08	-0.03	-0.01	-0.05	0.04	0.03	0.02	0.03	-	
17. Tchr Externalizing	-0.07	0.12	-0.09	0.04	-0.05	-0.14*	0.04	0.09	0.09	0.10	0.10	-0.03	-0.01	0.00	0.02	0.24**	-

* $p < .05$. ** $p < .01$

Table 19

Correlations Among Study Variables and Physiological Reactivity Variables for Males

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. RSA Rx3	-														
2. RSA Rx4	0.89**	-													
3. RSA Rx5	0.79**	0.80**	-												
4. SCL Rx3	0.01	0.02	0.07	-											
5. SCL Rx4	0.02	0.02	0.06	0.97**	-										
6. SCL Rx5	0.05	0.06	0.11	0.93**	0.97**	-									
7. Shyness	-0.02	0.03	0.09	0.06	0.04	0.06	-								
8. Positive Affect	-0.10	-0.10	-0.12	0.10	0.13	0.11	-0.18**	-							
9. Fear	-0.03	-0.06	-0.01	-0.01	0.03	0.05	0.09	0.25**	-						
10. Inhibitory Control	-0.12	-0.18*	-0.15	-0.01	-0.03	-0.01	-0.07	0.17*	0.01	-					
11. Approach	-0.09	-0.08	0.03	0.03	0.01	0.01	0.11	-0.47**	-0.19*	-0.03	-				
12. Activity	0.02	0.05	0.07	-0.02	-0.08	-0.06	0.14*	-0.67**	-0.23**	-0.26**	0.35**	-			
13. Parental Involvement	0.16	0.12	0.11	-0.09	-0.03	-0.01	-0.03	0.13	0.10	0.07	-0.26**	-0.22**	-		
14. Prnt Externalizing	0.11	0.16	0.07	0.00	-0.01	0.00	0.05	0.11	0.09	-0.13	-0.23**	-0.04	-0.10	-	
15. Tchr Externalizing	-0.02	0.01	0.01	0.02	0.02	0.05	-0.07	0.12	-0.09	0.04	-0.05	-0.14*	0.04	0.24**	-

* p < .05. ** p < .01

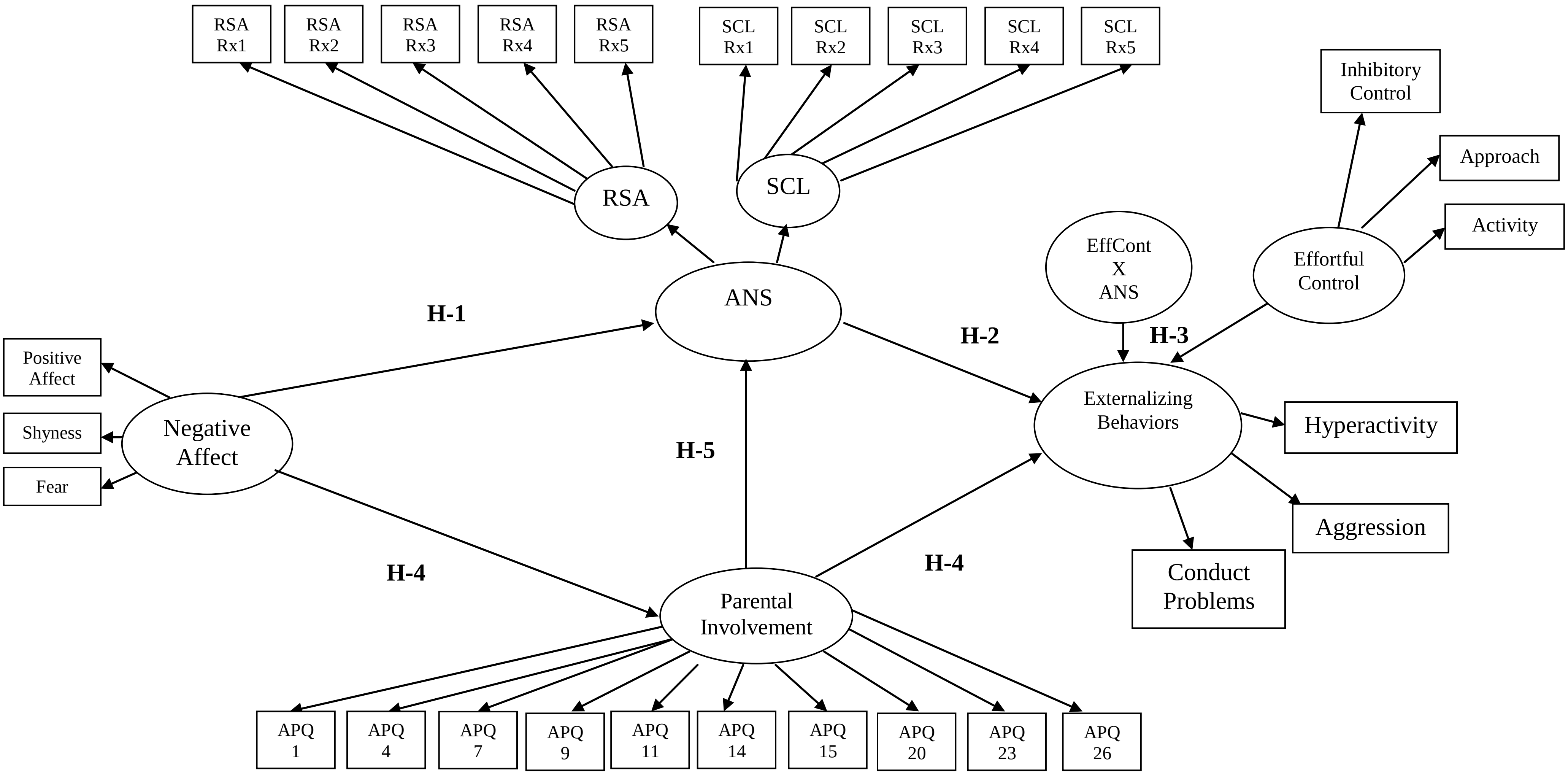

Figure 1. Global Model

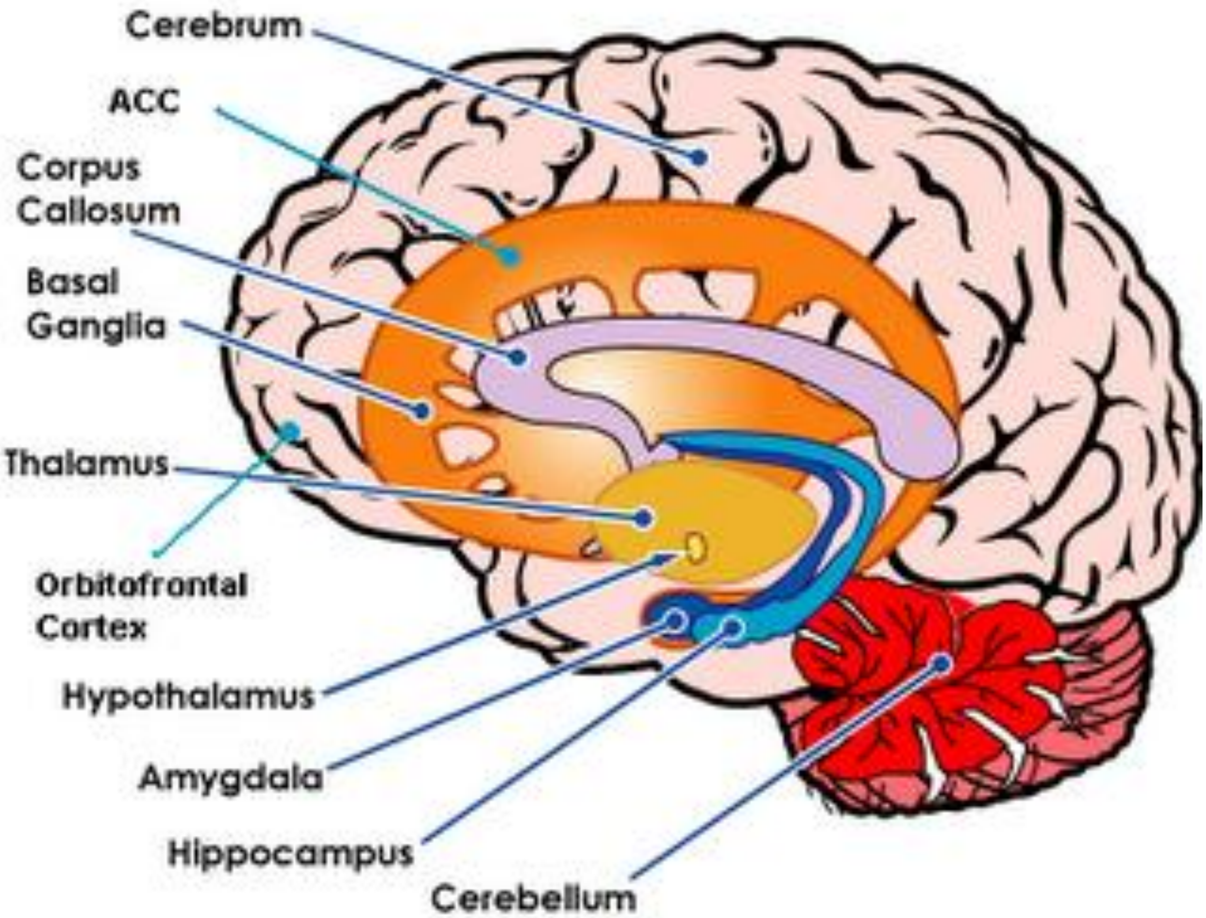

Figure 2. Brain diagram 1. Diagram of the basal ganglia and limbic system.

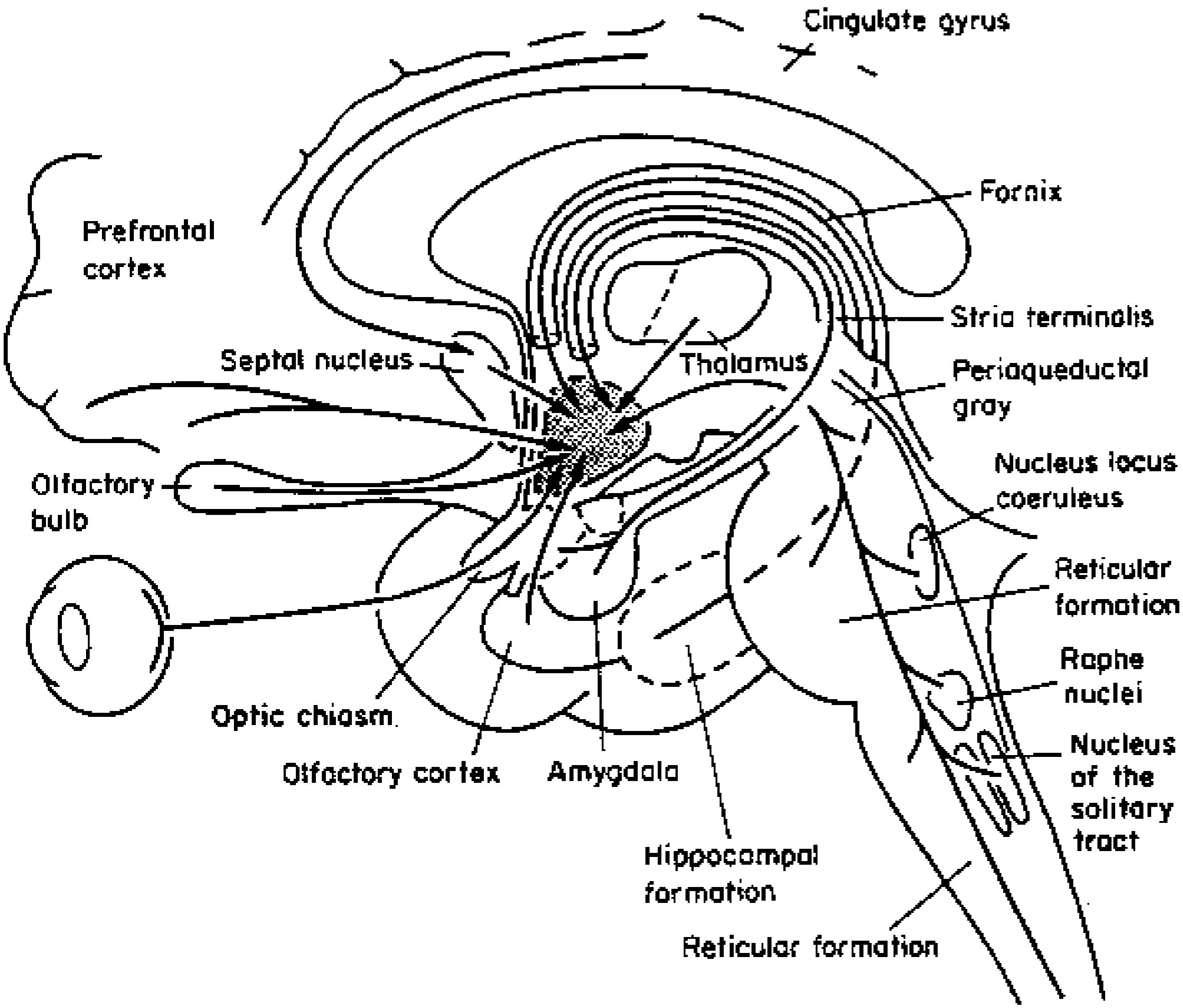

Figure 3. Brain Diagram 2. Brain and brainstem diagram demonstrating the NST and other nuclei.

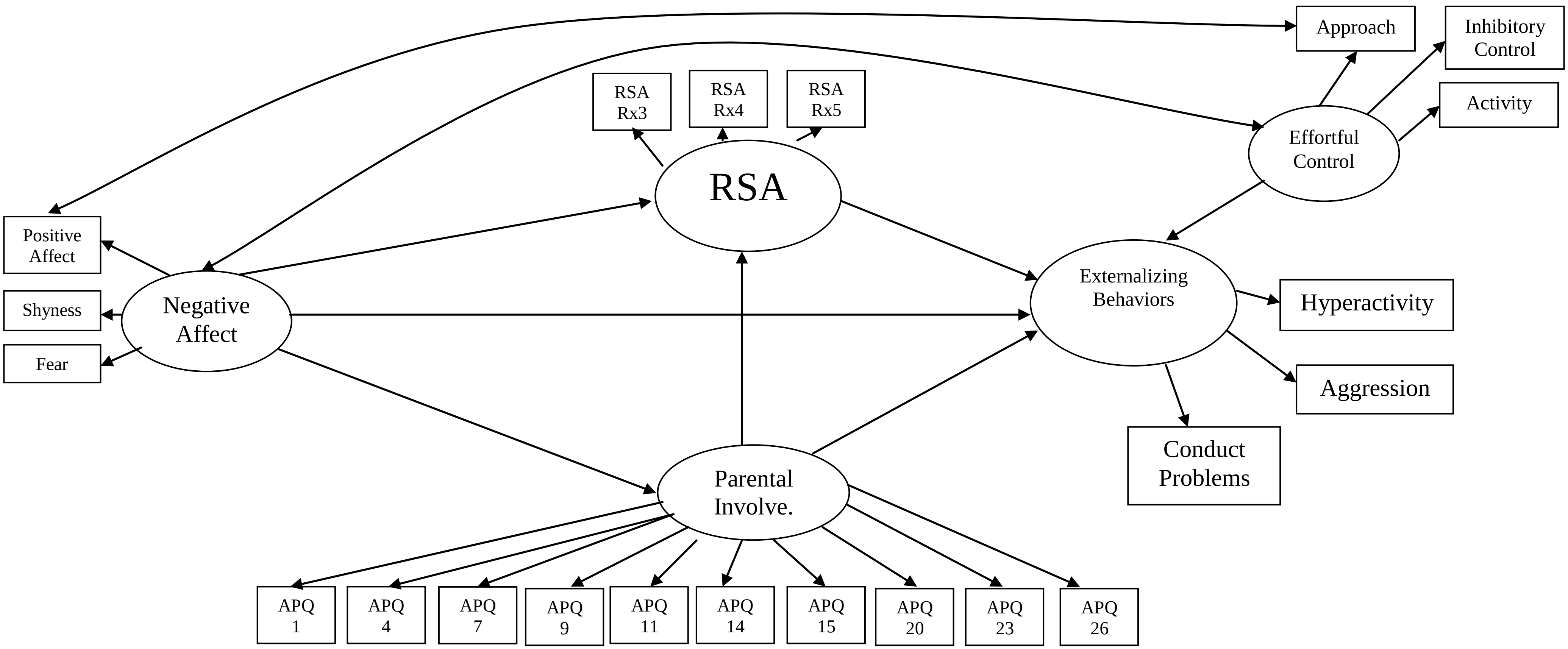

Figure 4.0. RSA Model

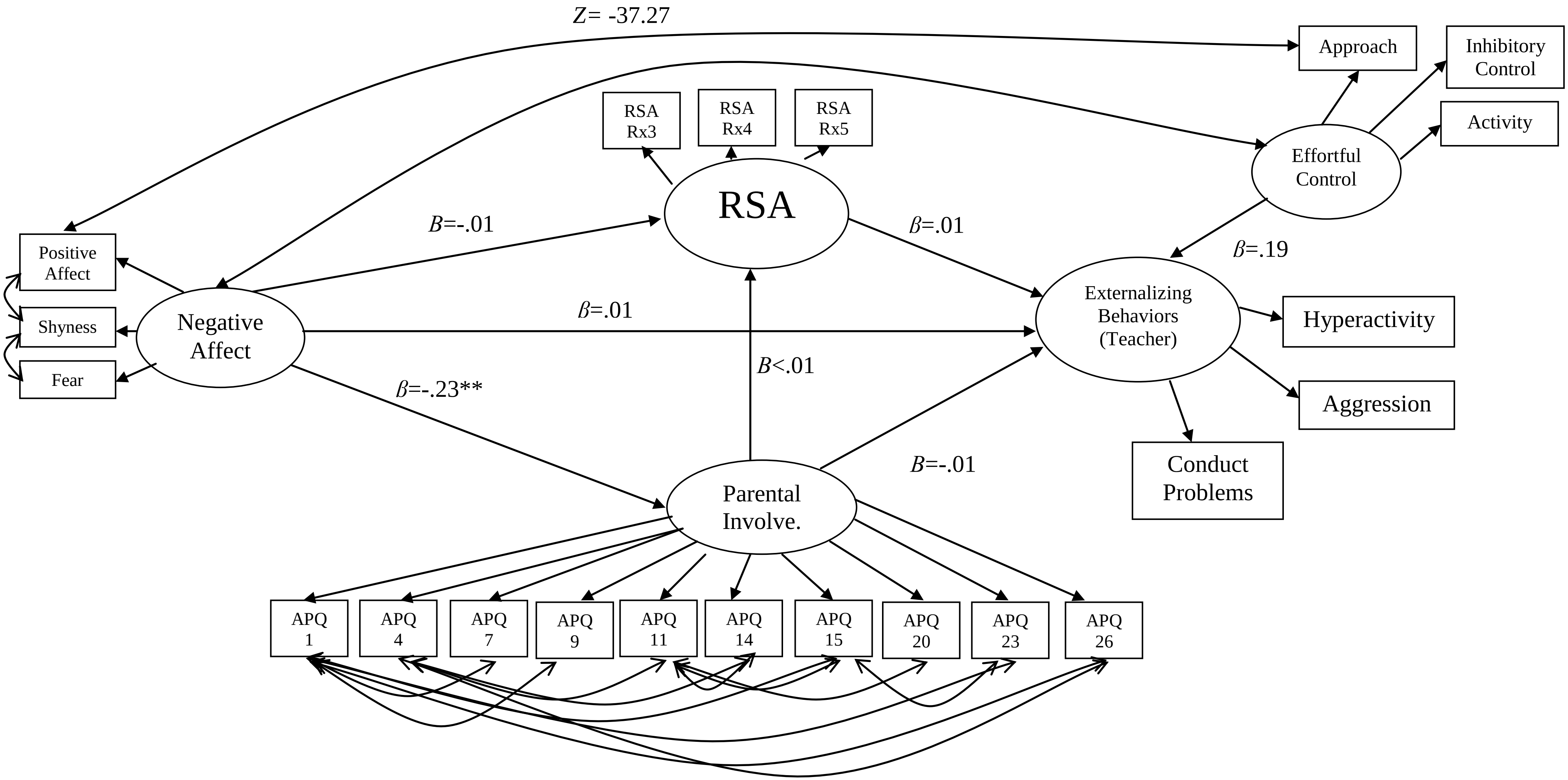

Figure 4.1 Modified RSA Teacher Model

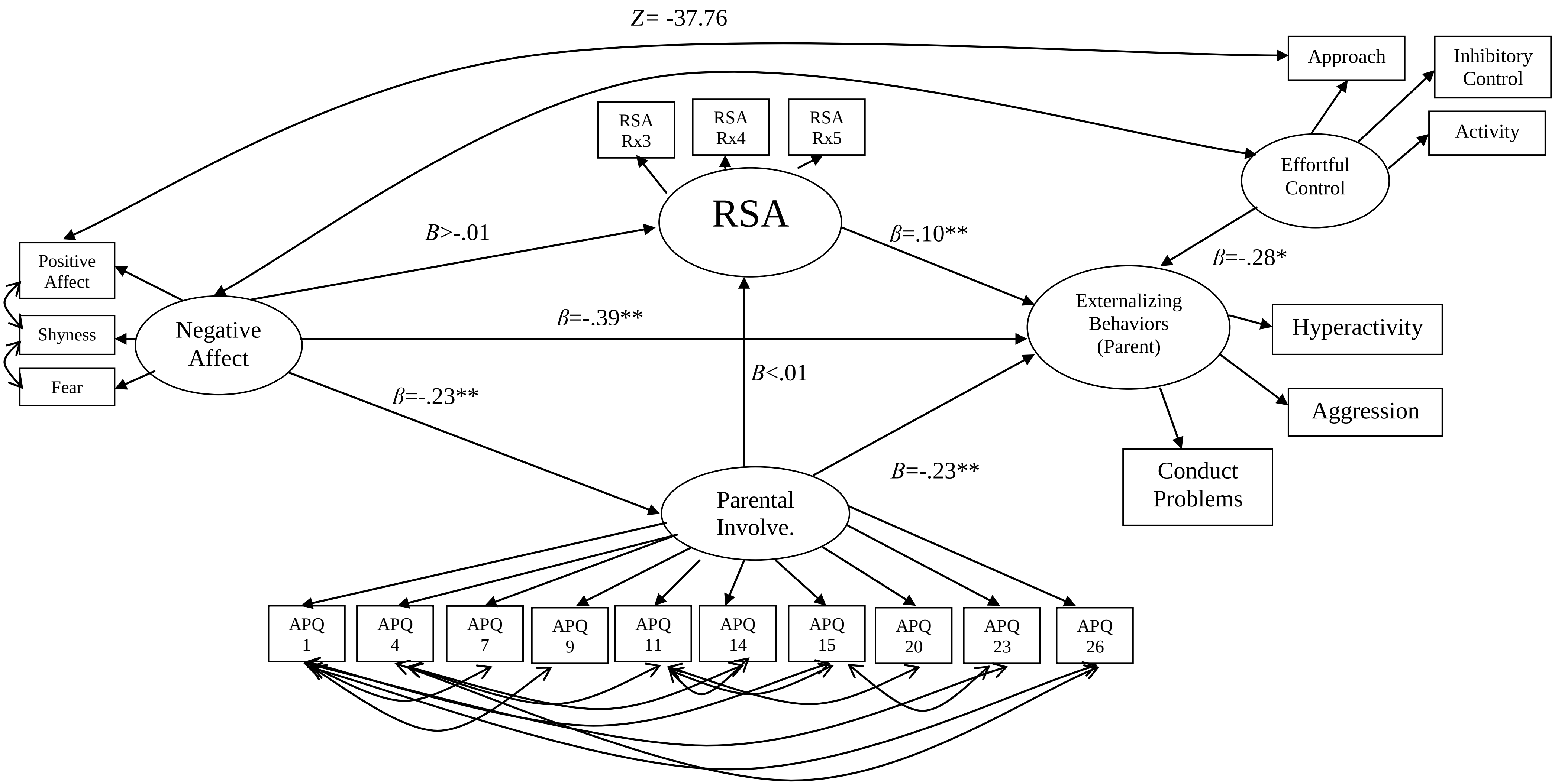

Figure 4.2 Modified RSA Parent Model

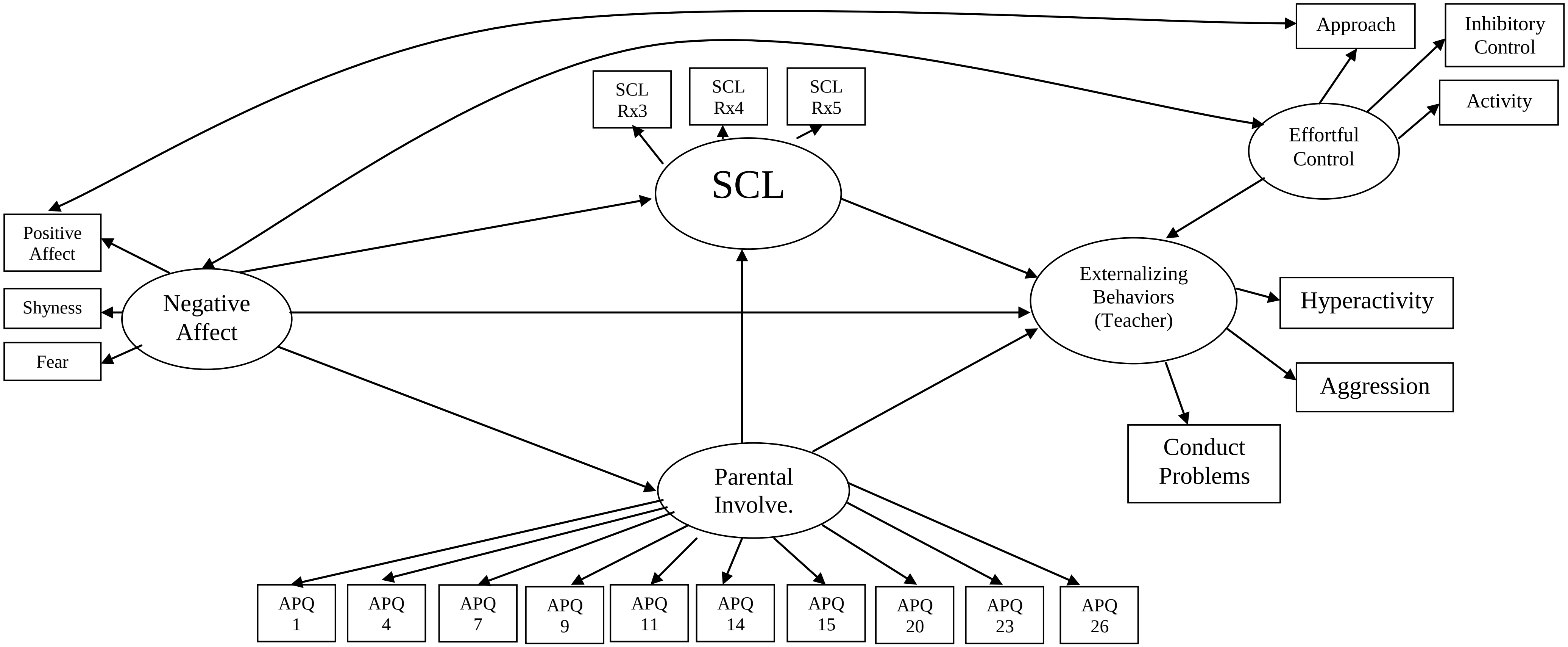

Figure 5.0. SCL Model

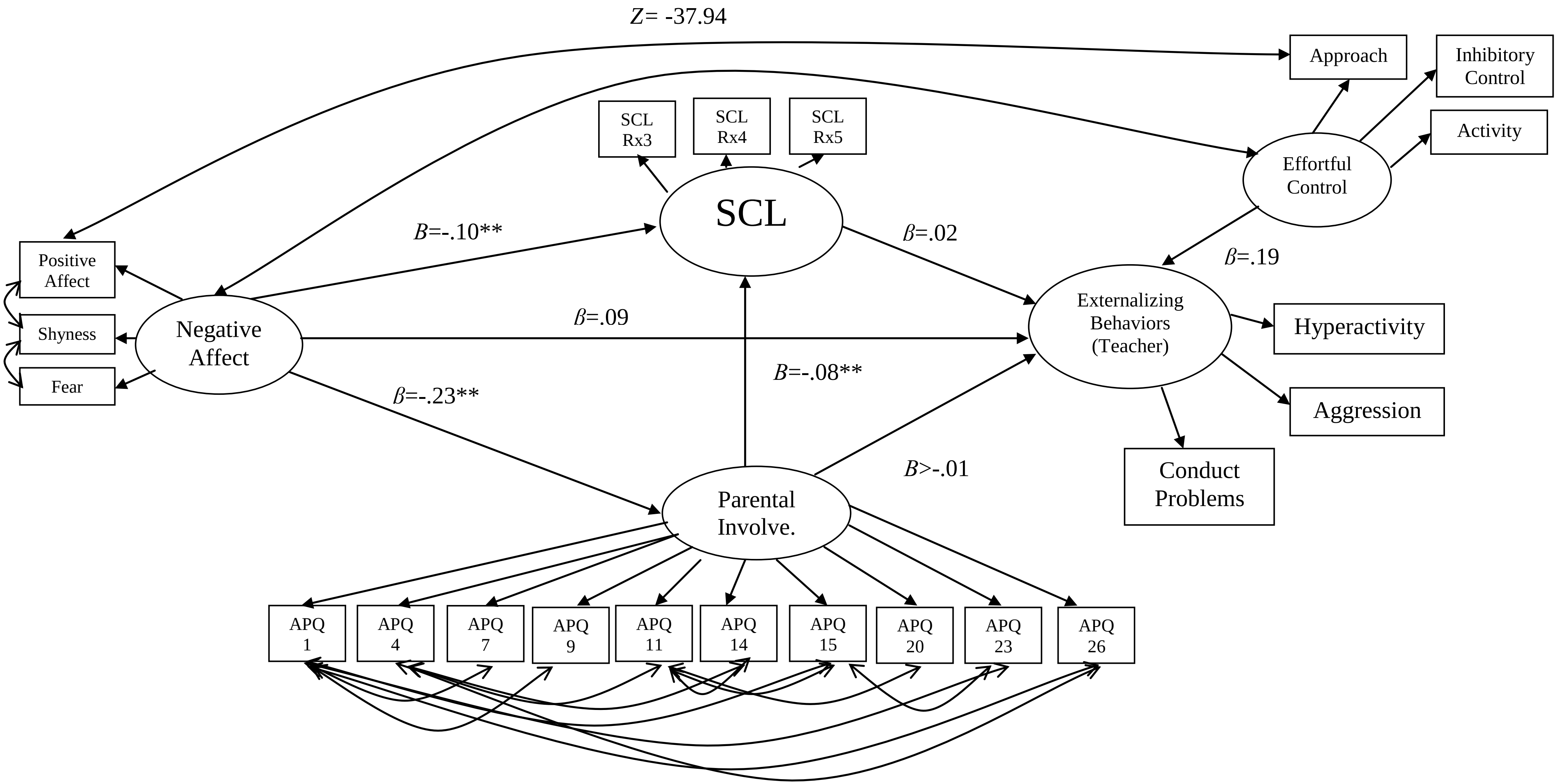

Figure 5.1 Modified SCL Teacher Model

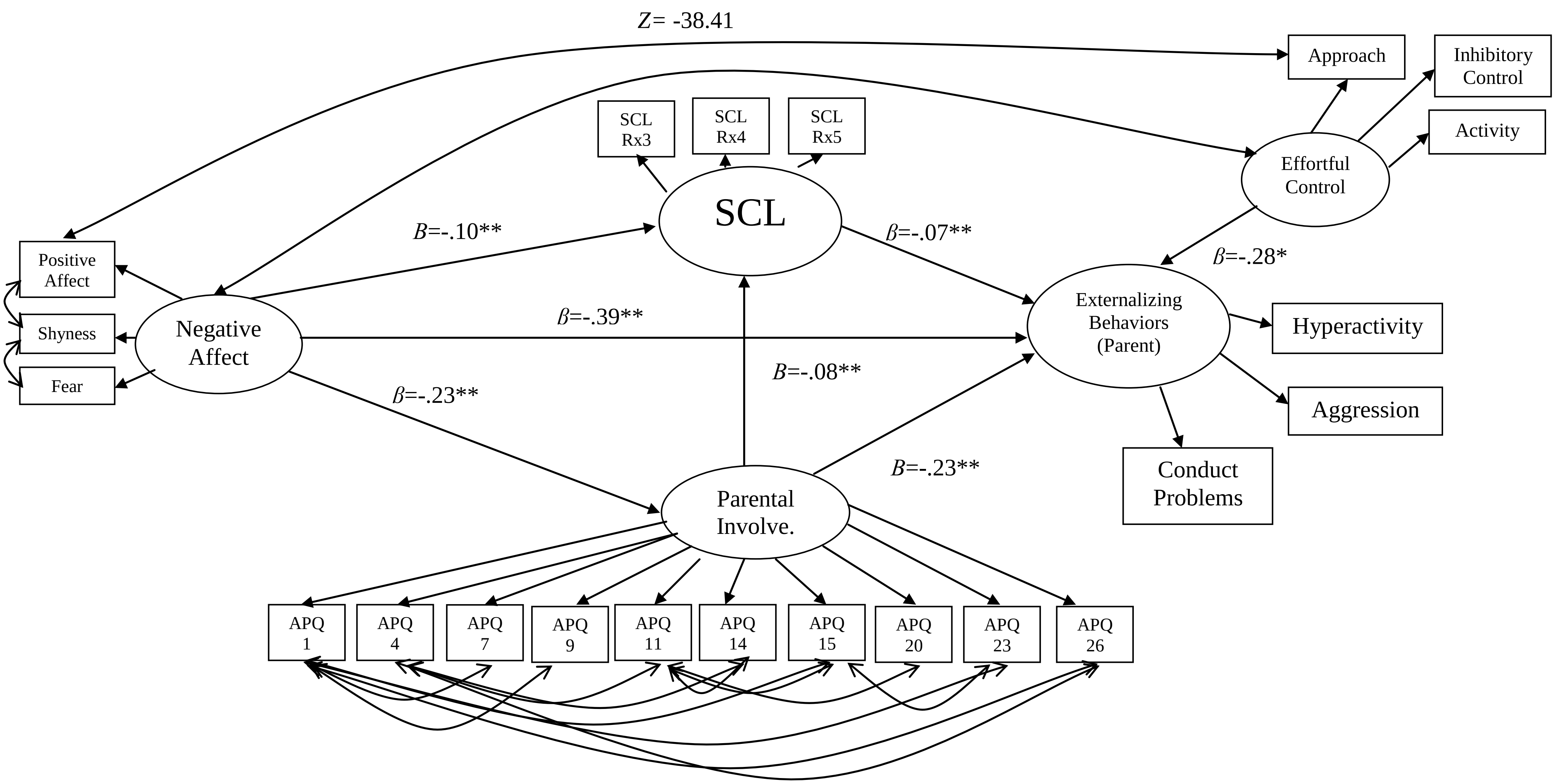

Figure 5.2 Modified SCL Parent Model