INDIVIDUAL DIFFERENCES IN RESPIRATORY SINUS ARRHYTHMIA AS A FUNCTION OF INTERNALIZING AND EXTERNALIZING SYMPTOMS

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TABLE OF CONTENTS

LIST OF FIGURES 7
LIST OF TABLES 8
ABSTRACT 9
CHAPTER ONE: INTRODUCTION 11
  Definition of Terms 21
CHAPTER TWO: LITERATURE REVIEW 24
  Emotion Development Theories 24
    Freud 25
    Bandura 26
    Bowlby 27
    Piaget 28
    Vygotsky 29
  Emotion Regulation 29
    Constructs of emotion regulation 29
    Polyvagal Theory 33
    Respiratory Sinus Arrhythmia 38
  Emotion Regulation Strategies 50
  Measuring Emotion Regulation 53
  Summary and Conclusions 55
CHAPTER THREE: METHOD 57
  Participants 57
  Measures 58
    The Behavior Assessment System for Children-Second Edition (BASC-2) 58
    Roberts' Apperception Test-Second Edition (Roberts-2) 60
    Respiratory Sinus Arrhythmia 63
    Paced breathing 64
    Attention task 64
    Self-regulation task 65
    Emotional reactivity task 65
    Neutral emotion task 66
  Procedures 66
  Data Analyses 68
CHAPTER FOUR: RESULTS 73
  Preliminary Data Analyses 73
    Research Aim 1 73

Research Aim 2 74
Research Aim 2a 75
Research Aim 2b 76
Research Aim 2c 76
Research Aim 2d 77
Hierarchical Multiple Regression Analyses 78
Natural breathing and RSA during attention task 78
Natural breathing and RSA during inhibition task 79
Natural breathing and RSA during a sad task 80
Natural breathing and RSA during an anger task 81
Research Aim 3 82
Additional Analyses 84
Paced breathing and RSA during attention task 85
Paced breathing and RSA during inhibition task 86
Paced breathing and RSA during a sad task 87
Paced breathing and RSA during an anger task 88
Repeated Measures of Analysis of Variance across RSA tasks 89
CHAPTER FIVE: DISCUSSION 91
Baseline RSA: Natural or Paced Breathing 92
Internalizing and Externalizing Behaviors Across Tasks 94
Anger Task 95
Attention Task 96
Inhibition Task 97
Sad Task 99
REFERENCES 105

LIST OF FIGURES

FIGURE 1 72

LIST OF TABLES

TABLE 1..........74
TABLE 2..........75
TABLE 3..........76
TABLE 4..........79
TABLE 5..........80
TABLE 6..........81
TABLE 7..........82
TABLE 8..........84
TABLE 9..........86
TABLE 10..........87
TABLE 11..........88
TABLE 12..........89
TABLE 13..........90

ABSTRACT

The purpose of this study is to examine how respiratory sinus arrhythmia (RSA) is affected across paced breathing, attention, inhibition, and emotion-eliciting tasks and how those relationships may be mediated by emotion regulation strategies in children with different levels of externalizing and internalizing behaviors between the ages of 8 and 12 years. The first aim was to determine whether externalizing and internalizing symptoms during a paced breathing or natural breathing task better predicted RSA levels. The hypothesis was that internalizing and externalizing behaviors would be more predictive of RSA baseline levels when utilizing a paced-breathing method of measuring RSA. The second aim was to determine how RSA levels across an attention, inhibition, sad, and anger task are predicted by internalizing and externalizing symptoms after controlling for baseline RSA levels. There were four hypotheses: (1) as levels of externalizing behaviors increase, levels of baseline RSA would decrease, (2) as levels of internalizing behaviors increase, levels of baseline RSA will decrease, (3) there will be significantly smaller changes in RSA reactivity) as the level of externalizing behaviors increases, and (4) as levels of internalizing symptoms increase, there will be significantly larger changes in RSA levels relative to RSA baseline levels (RSA reactivity).

The results showed that externalizing and internalizing behaviors did not predict RSA levels during a paced or natural breathing task. Additionally, there was very little difference in

the outcomes when used either a natural or paced breathing method of RSA as a control variable except when predicting RSA levels during a sad emotion-eliciting task. Although RSA levels during three experimental tasks (attention, inhibition, and sad) were not significant, there were moderate effect sizes for externalizing and/or internalizing symptoms predicting various RSA reactivity (i.e., RSA levels after controlling for baseline) across these conditions. One model was significant in predicting the level of variance of RSA reactivity during an anger emotion-eliciting task, with internalizing and hyperactivity/inattention symptoms contributing the most variation in the model. Findings point towards understanding how internalizing and externalizing symptoms may impact an individual's physiological response during a task.

CHAPTER ONE: INTRODUCTION

This chapter will cover general research findings pertaining to emotion regulation, including the differences in Respiratory Sinus Arrhythmia (RSA) as a function of internalizing and externalizing behaviors. Methodological issues that have confounded research on the physiological basis of emotion regulation as well as the potential mediating role of emotion regulation strategies are covered as well. This chapter also includes the purpose of the study, specific aims addressed in the study, definitions of significant terms, and the hypotheses associated with each of the aims.

RSA is a non-invasive measure of the parasympathetic nervous system. RSA specifically refers to the variations of heart rate in relationship to breathing (Butler, Willhelm, & Gross, 2006). There is evidence that RSA is linked to emotion regulation (Porges, 2001). Emotion regulation is the process of how one alters one's emotions that facilitates or hinders certain psychological processes such as attention, problem-solving skills, and building and maintaining relationships (Cole, Martin, & Dennis, 2004). Effective emotion regulation also helps to optimize the functioning of these psychological processes. During preschool and early childhood years, emotional regulation is an important skill that is developed (Thompson, 1994). Emotional regulation includes the ability to change, express or inhibit an emotion or an emotional reaction that ultimately helps one achieve one's goal.

Research has linked children who are able to effectively manage their emotions with positive peer relationships, resiliency, and academic success (Graziano, Reavis, Keane, & Calkins, 2007; Mcdowell, Kim, O'Neil, & Parke, 2002; Miller, Seifer, Stroud, Sheinkopf, & Dickstein, 2006). However, emotional lability has been associated with several negative outcomes such as poor peer relationships, behavioral problems, psychopathology, and academic difficulties (Feng, et al., 2008; Beauchaine, Gatzke-Kopp, & Mead, 2007; Bub, McCartney, & Willet, 2007; Denham, Blair, Schmidt, & DeMulder, 2002). Understanding how emotion regulation develops and predicts outcomes may guide researchers towards appropriate interventions for children who struggle with emotional dysregulation (Beauchaine, Neuhaus, Brenner, & Gatze-Kopp, 2008).

Emotional dysregulation tends to fall onto one of two dimensions, internalizing or externalizing as defined in Mash and Barkley's edited book (2003). Internalizing behaviors are generally characterized as emotional states and/or behaviors that are directed towards oneself, or inward. Examples of behaviors or emotional states that are classified as internalizing are crying, somatic complaints, worrying, anxiety, self-harm, guilt, and withdrawal. When severe and disruptive to daily functioning, internalizing symptoms can manifest as depression or anxiety. In contrast, externalizing disorders are distinguished by behaviors and/or emotional states that are directed outward towards others or objects. Arguing, anger, vandalism, lying, bullying, defiance, swearing, talking out of turn, and impulsivity are examples of behaviors and/or emotional states that are related to externalizing disorders. Clinical disorders that are considered to have externalizing symptoms include Oppositional Defiant Disorder, Conduct Disorder, and Attention Deficit Hyperactivity Disorder, whereas those disorders that have internalizing symptoms include Anxiety Disorders, and Mood Disorders.

Research examining emotion regulation strategies has found that individuals with internalizing symptoms use different kinds of strategies than individuals with externalizing symptoms. For instance, individuals with anxiety disorders have been found to use fewer problem-solving strategies than those without anxiety disorders (Suveg, Sood, Hudson, &Kendall 2008). Moore, Zoellener, and Mollenholt (2007) found that individuals that use expressive suppression strategies such as inhibiting an emotional response had higher levels of depressive and anxiety symptoms. Individuals with externalizing symptoms were more likely to catastrophize and blame others (Garnefski, Kraaij, & Van Etten, 2005). There is also evidence that externalizers are more likely to have displays of anger, less inhibition, and use more negative expression when disappointed (Eisenberg, et al., 2001). As a group, externalizers tend to display behaviors such as acting out, arguing, aggression, and fighting (Mash & Barkley, 2003).

Developing an understanding of the physiological aspects of internalizing and externalizing symptoms may be helpful in understanding individual differences in emotion regulation. Porges' (2001) Polyvagal Theory provided an integrative framework for researching and understanding social behavior in relation to the evolution of the autonomic nervous system. There are two branches of the 10th cranial nerve, vagus, that have developed for different behavioral strategies. Porges (2007) stated one vagal branch of the vagus nerve responds to environmental stimuli that indicate whether to engage in prosocial engagement behaviors while the other is primarily for states of immobilization. When social engagement and sustained attention are adaptive, the vagus nerve dampens the sympathetic input and decreases cardiac output by slowing down the heart rate and other metabolic systems. When 'fight or flight' behaviors are necessary, the input from the vagus nerve is withdrawn, which increases cardiac output by accelerating the heart rate and other metabolic systems. According to Porges (2007) when the "vagal brake is unable to regulate visceral state, then social engagement behaviors will be minimized" (p. 121). Porges (2007) hypothesized that individuals with emotional or behavioral disorders would have neurobiological systems that support fight or flight behaviors and not social engagement behaviors.

RSA has been commonly used in research as a non-invasive measure of parasympathetic activity and as an indirect measure of the vagus nerve. RSA measures the variability of heart rate in relation to the breathing pace of an individual (Grossman & Taylor, 2007; Butler et al., 2006).

A high RSA generally reflects that an individual's heart rate and breathing are more in sync than not. The literature on children with various presenting problems has shown evidence that a high baseline vagal tone or a high RSA level is indicative of a greater ability to engage in prosocial behaviors and greater attention abilities (Gottman & Katz, 2002; Porges, 2007; Willemen, Goossens, Koot, & Schuengel, 2008). Research has shown that children who have been maltreated have better academic performance when they are emotionally regulated (Schelble, Franks, & Miller, 2010). Additionally, research has also shown that children with higher emotional regulation predicted better academic performance even after controlling for IQ (Graziano, Reavis, Keane, & Calkins, 2007). Further research has shown evidence that high vagal suppression, as indicated by a larger decrease in RSA levels, during a stressful task is related to more behavioral problems, higher emotional reactivity, and psychopathlogy in at-risk and clinical populations (Calkins, Graziano, & Keane, 2007; El-Sheikh, Kouros, Erath, Cummings, Keller, et al. 2009; El-Sheikh, 2001; Porges, 2007). Beauchaine, Neuhaus, Brenner, and Gatzke-Kopp (2007) found decreased baseline RSA levels and decreased RSA levels relative to baseline RSA levels during emotionally stressful tasks in children with disruptive behavior disorders between the ages of 8 through 17 years of age. However, baseline RSA differences or significant differences in RSA reactivity were not found in children younger than 6 years of age.

Beauchaine et al. concluded that physiological differences in individuals with at-risk factors are not evident until after the preschool years.

Beauchaine et al. (2007) contended that early intervention is crucial for children who have at-risk factors for disruptive behavior disorders to disrupt the negative reinforcement of emotional instability and elevated autonomic arousal. Children with lower baseline RSA levels are more likely to act out by fighting, running, or freezing than children with higher levels of baseline RSA. Additionally, Beauchaine et al. theorized smaller RSA decreases in children with behavioral problems have more of an impact on their arousal system as their 'fight and flight' system is already comprised with a lower baseline level of RSA than children with a higher baseline level of RSA. In other words, emotionally charged situations are expected to decrease RSA levels in all children; however, minimal changes in RSA levels may be more impactful in children with externalizing behaviors. Beauchaine et al. hypothesized that the decreased levels of baseline RSA puts children at a higher risk for externalizing behavior problems because the threshold for acting out is breached more quickly and easier than children with higher levels of baseline RSA. However, researchers have employed a wide variety of research methods. The differences between study methods tend to confuse the findings of prior research.

Methodological issues confound the conclusions of prior research that uses RSA as an indirect measure of the vagus nerve. Specifically, RSA is impacted by the variability of breathing rates during emotion eliciting tasks. Not controlling for this fact can lead to errors in measurements and potentially false conclusions (Grossman & Taylor, 2007). Therefore, the introduction of a paced breathing task to control for respiratory effects on RSA may be crucial for interpreting results using RSA measures (Butler et al., 2006; El Sheikh, 2001). In contrast, Porges (2007) stated that controlling for breathing fundamentally changes the research questions that are posed by the Polyvagal theory. Accordingly, utilizing a paced breathing task as a control variable in measuring RSA prevents researchers from determining the vagus nerve influence on the parasympathetic nervous system and, therefore, the natural breathing rate of an individual is more appropriate. Research findings regarding RSA differences in emotion regulation may be mixed as a result of these two disparate methods of measuring baseline RSA.

Other variables that may have impacted conclusions drawn from prior research on emotion regulation are the connection of individual differences in cognitive processes with differences in emotional regulation (see Thompson, 1994 for a more in-depth review). Executive functions such as attentional control was related to emotion regulation in children between the ages of 7-10 years (Simonds, Kieras, Rueda, & Rothbart, 2007). Further research also found that the development of executive attention and effort control contributed to the overall development of emotion regulation skills (Porges, 2007; Posner & Rothbart, 2007; Rueda et al., 2005; Simonds et al., 2007). Jonsson and Sonnby-Borgstrom's (2003) research indicated that attentiondemanding tasks appear to increase RSA levels. Butler et al. (2006) also found that individuals who were instructed to suppress or reappraise emotional responses to a negative experience had their levels of RSA increase. The act of attending to the emotional response may have resulted in the increased levels of RSA. Consequently, determining how RSA changes may result from attending to a task is important, as attention may be a confounding variable in research findings.

Another potential confounding variable is inhibition. Executive functions such as inhibitory control are required for solving novel problems and selecting appropriate behavioral responses while suppressing competing ones (Fox, Henderson, Marshall, Nichols, & Ghera, 2005; Casey, Tottenham, & Fossella, 2002). Carlson and Wang (2007) found a relationship between inhibitory control and emotion regulation in 3 and 4 year olds. Children who were able to inhibit a response were also able to suppress negative emotions when presented with a gift that was not commonly perceived as rewarding (disappointing gift paradigm). However, inhibition in Carlson and Wang's research was defined as a child being able to suppress a negative emotion and not defined as a cognitive process of executive functioning. Inhibition as a measure of a cognitive process in terms of withholding a response in the presence of competing response on a task that was similar to the Stroop Color and Word task was found to decrease RSA levels in relation to baseline RSA in preschool aged children (Carlson et al., 2007). However, Munoz and Anastassiou-Hadjicharalambous (2011) found that behavioral inhibition did not correspond to a decrease in RSA levels during an error of commission computer task. Consequently, inhibition may be examined in two different ways in emotion regulation, as a strategy for regulating emotion or as a cognitive process that may confound RSA measures.

In summary, conclusions from prior research have been mixed, which may be due to the methodological differences including using a paced breathing task versus natural breathing, and a lack of understanding of the effects that attention and inhibition have on RSA. This study will add to the literature by delineating the effects of paced and natural breathing, attention, and inhibition on baseline RSA and RSA reactivity. The purpose of this study is to examine how RSA is affected across paced breathing, attention, inhibition, and emotion-eliciting tasks and how those relationships may be mediated by emotion regulation strategies in children with different levels of externalizing and internalizing behaviors between the ages of 8 and 12 years. Aims of this study included:

1) To determine whether or not internalizing and externalizing behaviors are more predictive of RSA levels when using a paced breathing method or a natural breathing method.
    a. Hypothesis 1: Internalizing and externalizing behaviors will be more predictive of RSA baseline levels when utilizing a paced-breathing method of measuring RSA.

2) To examine how baseline RSA levels and RSA reactivity (in relation to baseline RSA levels) during an attention, inhibition, and emotion eliciting tasks (sad and anger) are a function of parent and self-report of externalizing and internalizing behaviors

   Hypotheses 2a: As levels of externalizing behaviors increase, children's levels of baseline RSA will decrease.

   Hypotheses 2b: As levels of internalizing behaviors increase, children's levels of baseline RSA will decrease.

   Hypotheses 2c: There will be significantly less change in RSA levels relative to RSA baseline levels (lower RSA reactivity) as the level of externalizing behaviors increases.

   Hypotheses 2d: As children's levels of internalizing symptoms increase, there will be significantly larger changes in RSA levels relative to RSA baseline levels (RSA reactivity).

3) To investigate how emotion regulation strategies may mediate the relationship between baseline RSA and RSA Reactivity in children with varying levels of externalizing and internalizing behaviors. This aim is non-directional as there is not sufficient literature to support a hypotheses. In fact, there is very limited research that has examined the mediating effect of emotion regulation strategies on the

relationship between externalizing and internalizing symptoms and RSA baseline and reactivity.

Several factors are related to the emotion regulation process including attention, inhibition, and internalizing and externalizing strategies. Additionally, factors such as modeling, socialization, cognitive and age development, attachment security, problem solving skills, and language development are also important in the development of healthy emotion regulation. Effective emotion regulation has been connected to improved social and psychological functioning. Ineffective emotion regulation has been connected to poor outcomes such as internalizing and externalizing disorders, psychopathology, and social and psychological dysfunction. These links underscore the importance of understanding how to measure emotion regulation and strategies accurately as to enable those in the helping profession provide appropriate interventions for individuals at risk for emotion dysregulation.

Definition of Terms: Several different terms are used throughout the study. Based on the literature, the main terms are defined as follows:

Attention: mental focus towards a situation, thought, or stimuli.

Cranial Nerves: a set of nerves that convey motor and sensory information to and from the brain.

Emotion Regulation: the physiological, behavioral, and cognitive processes that an individual utilizes to modify or enhance his/her response to a given situation.

Emotional lability: the rapid fluctuation of emotions that are experienced by an individual (Thompson, 1994).

Externalizing Behaviors: a broad classification of behaviors that are directed towards others such as arguing, fighting, disruptive, and defiance (Mash & Barkley, 2003).

Inhibition: the ability to restrain an interfering thought or behavior.

Internalizing Behaviors: a broad classification of feelings or states that are directed inwards such as rumination, crying, nervous, somatic complaints, and withdrawn (Mash and Barkley, 2003).

Paced breathing: respiration at a predetermined rate.

Respiratory Sinus Arrhythmia (RSA): the naturally occurring rhythm of one's heart rate and breathing that is commonly used as a physiological measure of emotion regulation. Two terms are used to describe different ways of measuring RSA. Baseline RSA is the level of RSA during a resting state prior to any task manipulation. RSA reactivity is the level of change from baseline RSA to the RSA level during a task manipulation.

Parasympathetic: a component of the autonomic nervous systems that relaxes the body in response to a stimulus.

Sympathetic: a component of the autonomic nervous systems that readies the body for action in response to a stimuli.

CHAPTER TWO: LITERATURE REVIEW

This chapter contains a review of relevant literature, beginning with theories of emotional development. The next section describes the components of the emotion regulation process followed by coverage of emotion regulation strategies. Findings related to the impact of internalizing and externalizing disorders on emotion regulation are also included. This chapter also addresses measurement issues as it relates to emotion regulation, including a discussion of physiological measurements, self-reported instruments, and projective techniques.

Emotion Development Theories

There are several theories regarding how children develop, express, and regulate emotions. Freud (1923), Bandura (1986), Bowlby (1980), Vygotsky, and Piaget each theorized how an individual developed psychologically, socially, or cognitively that have implications about the development of emotion regulation. Freud and Bowlby's theories center around how a child's internal world develops from the interactions with his or her parents. In contrast, Bandura's theory stated that children learn through observing their friends, parents, and other adults that they come into contact with on a regular basis. Vygotsky's theory was focused on how children internalized the external world through speech. However, Piaget's theory of cognitive development stated that children develop more from an internal process that is biologically driven.

Freud. Sigmund Freud is credited with being the father of psychology. Freud's theory is complex and multifaceted. Freud (1923) conceptualized the human personality as being structured into three different components, which are the id, ego and superego. According to Freud, each individual is born with the id. The id is driven by the pleasure principle and with the primary focus to get the most basic needs met. In the infant, the id does not consider anything else other than one's own needs and getting those needs met. As the infant matures and interacts with the world and other humans, the ego then develops. The ego acts on the reality principle and is able to consider the needs and desires of other humans while attempting to meet the person's own needs. The third part of the personality is the superego, our moral and conscience center. The superego develops based upon the moral and ethical constraints put upon children by their caregivers. Freud stated that in a child, there needs to be a healthy balance achieved by the ego that attends to the needs and desires of the id while ensuring that the morals and conscience of the superego are also met. When the id or superego is the driving force behind an individual's personality, the person develops interpersonal conflicts. Freud stated that to avoid anxiety of the ego becoming eliminated by the super-ego, the ego employs several different types of defense mechanisms in order to eliminate the anxiety of impulses that conflict with the ideals of the super-ego. Defense mechanisms are a variety of different strategies that are employed to keep the id or the superego satisfied. Ten different defense mechanisms have been identified; denial, displacement, intellectualization, projection, rationalization, reaction formation, regression, repression, sublimation, and suppression. Each of these defense mechanisms expresses themselves in different ways and is utilized as a method to control anxiety (Garber & Dodge, 1991).

Bandura. Albert Bandura (1986) stated that individuals learn through observing others and that learning occurs rapidly in large sequences rather than in a gradual process that require continual reinforcement. Individuals are able to learn from two types of models, live and symbolic. Live models are individuals such as caregivers, peers, or other adults that children come into contact with physically. Symbolic models are ones that individuals do not physically come in contact with on a regular basis instead they are individuals from movies, TV, or characters in a book. According to Bandura (1986) children can "acquire…new patterns of behavior by observing the performance of others," (p.49). In his classic research experiment, Bandura, Ross, and Ross (1961) demonstrated that children who observe an adult acting aggressively towards a doll were more likely to act aggressively towards the doll than children who did not observe the aggressive behavior. Bandura's social learning theory posited that children develop patterns of behavior through imitation and observation. Another construct of Bandura's theory that contributes to emotion regulation is self-efficacy. Self-efficacy is the perception that an individual has of one's own ability to be successful in the endeavors he/she pursues. The belief that an individual has about one's own ability is central to how one thinks, acts, and respond emotionally to stressful situations (Bandura, 1986). Consequently, the social world in which a child is raised and exposed to will contribute to the patterns of behavior that the child will develop in order to regulate and maintain his/her emotions. One's belief in how effective one will be in achieving individual goals activates a set of actions and consequences that enhance or decrease one's ability to regulate emotion.

Bowlby. John Bowlby's attachment theory explains the natural tendency of human beings to form emotional bonds with other human beings and understand emotional difficulties and personality disturbances (Bowlby, 1980). Attachment behaviors are those behaviors that an individual uses in order to maintain or attain proximity to the primary caregiver and thereby ensuring one's own safety and survival. The repeated interaction between the primary caregiver and a child leads to the development of internal working models of the self and of others. A primary caregiver who responds appropriately and consistently to the attachment behaviors of a child is considered to be a secure base. This secure base serves as a point of reference from which one can return to receive support and nurturing in times of distress while at the same time allowing the child to explore, play, and engage in social activities (Bretherton & Munholland, 1999). However, when the primary caregiver does not respond consistently, responds inappropriately, or both than the child develops "disturbed patterns of attachment behaviors," (Bowlby, 1980, p. 41). Bowlby further stated that these behaviors are active throughout the life cycle and serve as a guide for other attachment bonds. Children regulate their emotions through their sense of security to their primary caregiver.

Piaget. Piaget (1952) stated that children develop their cognitive skills in a series of developmental stages. There are four stages along a continuum that children go through in their cognitive developmental process: Sensorimotor (0-2 years), Preoperational (2-7 years), Concrete Operations (7-11 years), and Formal Operations (11-15 years). According to Piaget, an infant begins to experience feelings such as joy, sorrow, pleasantness, and unpleasantness between 1-4 months of age. During the Preoperational stage, children begin to become more stable in their feelings and behaviors as they are able to reconstruct past events largely through the development of spoken language. In the next stage, Concrete Operations, children are able to conserve their feelings and values and are able to "coordinate their affective thoughts from one event to another" (Wadsworth, 1989, p. 106). Due to the cognitive development of a child, Piaget (1952) stated that children's self-regulation is primarily the role of their will, which are the values and beliefs that the child has and follows. Children also develop autonomy of their thoughts and feelings around the ages of 7 or 8 years that allows them to make their own decisions about their actions. Children develop the ability to decide whether an action or behavior is appropriate or inappropriate and how those actions affect others.

Vygotsky. Vygotsky (1934) hypothesized that language was a tool that enabled humans to develop thought and social interaction. Through the process of learning language, Vygotsky stated that children are increasingly able to solve problems. The use of language as a tool to solve problems is evident in the stage of egocentric speech. Similar to Piaget's observations, Vygotsky observed that children around 3 years of age have egocentric speech that lacks verbal exchanges with others. However, unlike Piaget, Vygotsky (1934) stated that the stage of egocentric speech is the process of stating verbally ones' observations about one's own actions and predicting the results of those actions are essentially problem solving skills. Once the process of internalizing speech occurs, discerning how one solves problems and manage one's internal emotional state becomes difficult. Additionally, the cultural context in which one is raised in plays an important part in the development of social learning, which includes learning to regulate emotion. Children learn their cognition skills from the culture that they are raised within and from the social interactions that they engage in with peers and adults.

Emotion Regulation

Constructs of emotion regulation. Several different components work together to comprise what is known as emotion regulation. The literature on emotion regulation has traditionally been fraught with difficulties in explicitly stating a shared definition of emotion regulation (Thompson, 1994). Thompson (1994) defined emotion regulation with the following statement: “Emotion regulation consists of the extrinsic and intrinsic processes responsible for monitoring, evaluating, and modifying emotional reactions, especially their intensive and temporal features, to accomplish one’s goals,” (p. 28). According to Thompson, there are several components of emotion regulation that interact with one another that hinder or help one to reach his/her goals: emotion lability, discrete emotion, inhibition, and attention. As research continued in emotion regulation, Thompson (2008) reassessed his definition of emotion regulation to include research findings that indicated neurobiological components such as the parasympathetic system.

The term emotional lability commonly refers to an individual whose emotional reactions are considered maladaptive to the context in which they are expressed (Thompson, 1994). Emotion lability also refers to the emotional response of an individual that changes rapidly and/or varies in the type of emotion conveyed. The emotional response of an individual can be defined in terms such as discrete emotions, behaviors, or physiological responses. Thompson (1994) referred to discrete emotion as the feeling or state such as anger, anxiety, sad, or happy. These discrete emotions differ from the processes that regulate emotions. Emotional lability refers to how an individual may vary between the feelings of anger and sadness or happiness (Thompson, 1994).

Early research in emotion regulation connected individual differences in cognitive processes and physiological reactivity with differences in emotional regulation. Cognitive processes such as inhibitory control are required for solving novel problems and selecting appropriate behavioral responses while suppressing competing ones (Fox et al., 2005). Additionally, lack of inhibition control has been associated with behavior and emotion regulation problems (Berlin & Cassidy, 2003; Carlson & Wang, 2007; Cheavens et al., 2005; Feng et al., 2008; Golden & Golden, 2002; Inzlicht & Gusell, 2007; Schatz et al., 2008; Simonds et al., 2007; Thompson et al, 2004). Thompson (1994) described emotion regulation as a process that includes the ability to inhibit an emotional response. Individuals who are unable to inhibit a response that is detrimental to achieving their goal have inter- and intra-personal difficulties.

Carlson and Wang (2007) found a relationship between inhibition control and emotional regulation in preschool aged children. Children who were able to inhibit a response were also able to suppress negative emotions during a disappointing gift paradigm. In their study, Carlson and Wang observed 53 three children between the ages of 51-72 months. The children were observed in one session at a laboratory playroom. The following measures were administered to the children in a fixed order by two experimenters: the Peabody Picture Vocabulary Test-III (PPVT-III); Simon Says (Inhibition); Forbidden Toy (Inhibition); Emotion Understanding (Emotion Regulation); Secret Keeping (Emotion Regulation); Gift Delay (Inhibition);

Disappointing Gift (Emotion Regulation). The parents of the children completed two different questionnaires, a 33-item Self-Control Rating Scale and a 6-item Emotion Regulation Rating Scale. The results showed even after controlling for verbal ability and age, children who were able to inhibit responses were also able to suppress negative emotional responses during the Disappointing Gift Paradigm indicating the executive function of inhibition is an important component of emotion regulation. Limitations of this study were that inhibition was defined as the ability to withhold an observable behavior rather than using a standardized measure and no physiological measures were utilized.

The development of executive attention and effortful control contribute to the overall development of emotion regulation skills (Porges, 2007; Posner & Rothbart, 2007; Rueda et al., 2005; Simonds et al., 2007). Simonds et al. (2007) found similar results to Carlson and Wang (2007) in children between the ages of 7-10 years. Simonds et al. measured 49 children's effortful control with self-report and parent report of the Temperament in Middle Childhood questionnaire (TMCQ), and attention with the Attention Network Task (ANT). Each child attended three different sessions, the first was the completion of the ANT, the second was completion of the TMCQ and part one of the mistaken gift paradigm where the researchers has the child rank his or her preference for a gift and then gives the child the first preferred gift. The third session had the child complete the TMCQ and ANT and the researcher presented the child with the least preferred gift. After a delay of 15 seconds, the researcher commented that a mistake was made and then preceded to give the child the second most preferred gift. The results demonstrated that children's level of effortful control was significantly correlated to attention capacities, which is considered the mechanism necessary for effortful control or inhibition. However, a limitation of this study was that attention and inhibition were not separately assessed, creating ambiguity in the interpretations of the results. The question then remains: Are the significant results between emotion regulation and effortful control and attention a result of inhibition or attention processes?

The Polyvagal Theory. Porges (1994) introduced the Polyvagal Theory as a framework for understanding the neurological underpinnings of the social engagement system. The Polyvagal Theory is a dynamic theory that has developed and expanded since its original conception to include new components based on research findings. The theory postulates that the vagus nerve controls and regulates the heart rate and metabolic systems in order to facilitate social engagement, fight or flight, and immobilization behaviors. Porges' (1995) claimed that respiratory sinus arrhythmia (RSA) was a non-invasive measure of the vagus nerve that researchers may use to understand the psychological processes that are associated with the two divisions of the autonomic nervous system, parasympathetic and sympathetic. According to

Porges (2007), the Polyvagal provides a theoretical framework from which to develop hypotheses and research and interpret findings about the autonomic nervous system.

Neuroception was a term that was coined by Porges (2003) to describe the first stage in the Polyvagal theory. Porges states that for an individual to form an attachment or a social bond, the individuals must perceive each other and the environment as safe. Unconsciously evaluating the environment and individuals for perceived danger or safety is what Porges defined as the process of neuroception. By processing information that is received from the senses, one is continuously assessing for risk to one's safety. Once an individual perceives that he or she is safe then that individual will engage in prosocial behaviors. However, if that individual determines that other people or the environment is not safe than the individual will engage in defensive behaviors. Neuroception determines whether the vagus nerve dampens or withdraws its' influence on the parasympathetic nervous system.

The vagus nerve, also known as the tenth cranial nerve, is located in the medulla section of the brainstem and is connected to the nucleus ambiguous, dorsal motor nucleus, nucleus solitarius, and trigememinal nuclei (Blumenfeld, 2002). Cranial nerves' major purpose is to provide motor and sensory information to and from the brain. The primary function of the vagus nerve is to provide parasympathetic stimulation to the heart, lungs and digestive tract. This function of the nerve is a key component to the Polyvagal theory. When the vagus nerve innervates the heart, the heart rate slows down. According to the Polyvagal theory, the vagus nerve serves as a brake that slows down the heart rate, pupils are contracted, and salivation and digestion is stimulated (Porges, 2007; Porges, 2003; Porges, 2001; Porges, 1998; Porges, 1995). In this state of rest, an individual is then able to engage in pro-social behaviors. However, when the 'vagal brake' is removed, the sympathetic system arouses the body to prepare for fighting or fleeing. When the body is aroused by the sympathetic system, the heart rate is accelerated, salivation and digestion is inhibited, pupils dilate, and glucose is released (Kolb & Whishaw, 2009). Porges' (Porges, 2007; Porges, 2003; Porges, 2001; Porges, 1998; Porges, 1995) theory states that the individual is then primed for fighting or fleeing behaviors and is not able to engage in prosocial behaviors.

The Polyvagal theory hypothesizes that the autonomic system has three subsystems that are organized in a hierarchical manner. The subsystems are social engagement, mobilization, and immobilization (Porges, 2007; Porges, 2003; Porges, 2001; Porges, 1998; Porges, 1995). According to Porges, each of these systems is utilized by the order of their evolutionary development. Borrowing from the Jacksonian principle of dissolution, Porges (2007) stated that when a higher subsystem is rendered functionless, then the next older system takes over. Consequently, the social engagement system, which is the most recent system to have developed, is utilized first. When the individual evaluates the context to be unsafe by the process of neuroception, the social engagement system is inhibited and the mobilization unit is uninhibited. The final and most primitive system, immobilization is activated when the other two systems have not succeeded in protecting the individual from harm.

Each subsystem is responsible for different types of behaviors that are initiated in response to one's assessment of risk or safety in the environment. As the name implies, the social engagement system is primarily responsible for behaviors such as social communicating, self-soothing, calming, and inhibiting arousal (Porges, 2007; Porges, 2003; Porges, 2001; Porges, 1998; Porges, 1995). In addition to the vagus nerve being responsible for providing parasympathetic information to the heart, this tenth cranial nerve mediates several functions. These functions include innervating throat muscles responsible for swallowing and speaking, receiving input from the pharynx, meninges, epiglottis and larynx, as well as chemoreceptors and baroceptors (Blumenfeld, 2002). Chemoreceptors receive information that indicates low levels of dissolved oxygen and carbon dioxide, which then stimulate sympathetic activity and inhibit parasympathetic activity (Purves et al., 2004). Baroreceptors send signals indicating increased blood flow, which creates signals to decrease heart rate and contractions. The information is sent from the aortic arch, cardiorespiratory system and digestive tract (Blumenfeld, 2002). Porges (2007) states that cranial nerves V, VII, IX and XI also comprise the social engagement system and engaging in social interactions with individuals requires skills that are mediated by each of these nerves.

The cranial nerves have specific functions that help an individual interact with others. For example, cranial nerve V (trigeminal nerve) and VII (facial nerve) control facial expressions, which are important components of communication (Porges, 2007; Porges, 2003; Porges, 2001). Furthermore, the facial nerve innervates the stapedius muscle to contract, which dampens how one hears his/her own voice and allows the human voice to be filtered out from extraneous noises (Blumenfeld, 2002; Porges, 2001). Cranial nerves XI (glossopharyngeal nerve) and X (vagus nerve) are involved in intonation and prosody as these nerves provide input to the larynx and pharynx. Social gestures and orientation from head turning muscles receives innervations from cranial nerve XI, spinal accessory nerve (Porges, 2007; Porges, 2003; Porges, 2001). Collectively, these cranial nerves comprise the social engagement system.

The social engagement system is utilized when the environment is deemed, through the process of neuroception, to be free from the danger of harm to the self, physically or emotionally (Porges, 2007; Porges, 2003; Porges, 2001). However, when the vagal brake withdraws its influence from the heart, input from the sympathetic nervous systems mobilizes the body for ‘fight or flight’ behaviors. An individual who is in a state of mobilization is unable to engage in behaviors that are conducive to building social bonds and attachments to other human beings.

The Polyvagal theory states that the mobilization system is biologically incompatible with the social engagement system thus when one is engaged the other is disengaged. The sympathetic nervous system primarily receives and sends input via the sympathetic ganglia that are a collection of nerve cells, which control the internal organs (Kolb & Whishaw, 2009).

The third system, immobilization, is characterized by behavioral shutdown and deathlike behaviors. Porges (Porges, 2007; Porges, 2003; Porges, 2001; Porges, 1998; Porges, 1995) stated that the immobilization system is the most primitive of the three systems and is the last system to engage. The immobilization system is controlled by the unmyelinated vagus that originates in the dorsal motor nucleus, unlike the social engagement system, which is controlled primarily via the myelinated vagus and originates from the nucleus ambiguous. In the state of immobilization, an individual’s heart rate slows down, breathing becomes shallow, and movement ceases in order to conserve resources and protect the individual when he or she is unable to fight or flee from danger (Porges, 2007; Porges, 2003; Porges, 2001; Porges, 1998; Porges, 1995).

Respiratory Sinus Arrhythmia. A growing body of literature has shown that Respiratory Sinus Arrhythmia (RSA) is related to emotion regulation. As a result, RSA is now commonly used as a physiological measure of emotion regulation in children and adults (Beauchaine et al., 2007; Bosch et al., 2009; Butler et al., 2006; Calkins et al., 2007; El-Sheikh et al., 2009; El-Sheikh, 2001; Forbes et al., 2006; Gottman & Katz, 2002; Greaves-Lord et al., 2007, Hastings et al, 2008; Hinnant & El-Sheikh, 2009; Jonsson & Sonnby-Borgstrom, 2003; Licht De Gues, Van Dyck, & Penninx, 2009; Rottenberg et al., 2005; Santucci et al., 2008, Watkins, Grossman, Krishnan, & Sherwood, 1998; Willemen et al., 2008). Porges (2007) stated that RSA is a non-invasive measure of vagal tone. RSA measures the intermittent fluctuations of the heart rate in relation to an individuals' breathing rate (Butler et al., 2006). Grossman and Taylor (2007) stated that RSA is a representation of the vagal influence on the sinoatrial node, which acts as the heart's pacemaker and consequently is often used as a measure of the parasympathetic control of the heart. Within-person and between-person changes in RSA have been researched to examine emotion regulation (Beauchaine et al., 2007; Bosch et al., 2009; Butler et al., 2006; Calkins et al., 2007; Dietrich et al., 2007; El-Sheikh et al., 2009; El-Sheikh, 2001; Forbes et al., 2006; Gottman & Katz, 2002; Greaves-Lord et al., 2007, Hastings et al, 2008; Hinnant & El-Sheikh, 2009; Jonsson & Sonnby-Borgstrom, 2003; Licht et al., 2009; Rottenberg et al., 2005; Santucci et al., 2008, Watkins et al., 1998; Willemen et al., 2008). Baseline RSA refers to an individual's RSA level when he or she is at a resting state. RSA reactivity is the amount of change from baseline RSA to RSA levels during a specified task. High RSA refers to when an individual's respiration and heart rate are in sync, thereby indicating that the individual is in a resting state and has more input from vagus nerve as opposed to low RSA.

There is evidence that cognitive processes, such inhibition and attention, have effects on baseline RSA and RSA reactivity levels (Duschek, Muckenthaler, Werner, & Reyes del Paso, 2009; Hansen, Johnson, & Thayer, 2003; Richards, 1994; Suess, Porges, & Plude, 1994). Duschek et al. (2009) found that in healthy individuals, a sustained and discriminatory attention task was related to lower levels of RSA during task performance indicating that as individuals are performing attentional tasks, RSA levels decreased, regardless of performance. Inhibition has primarily examined as a behavioral measure and not as a cognitive process. Therefore, research examining inhibition as a component of executive functioning and its effects on RSA has been limited. However, two studies have examined executive functioning and vagal tone (Mezzacappa, Kindlon, Saul, & Earls, 1998, Munoz, & Anastassiou-Hadjicharalambous, 2011). Mezzacappa et al. (1998) utilized measures that included the Stroop color-word task and Trail Making Part B. In a sample of 42 children, with a mean age of 10 years, higher baseline RSA was associated with better performance on executive functioning tasks, including inhibition measures. These findings demonstrate that simply doing an inhibition task results in lowering RSA levels. Further, lower levels of baseline RSA may be associated with difficulties inhibiting incorrect responses and/or attending to important features of tasks. Munoz and Anastassiou-Hadjicharalambous (2011) examined RSA in relation to behaviorally inhibited or behaviorally uninhibited children during an error of commission task on the computer. Children between the ages of 4.5 years and 5.5 years were rated as behaviorally inhibited or behaviorally uninhibited based on select items from the Children's Behavior Questionnaire. The researchers found no correlations between RSA reactivity and children's performance on an error of commission task, which may be a result of the age of the participant as RSA differences may not occur until middle childhood (Beauchaine et al., 2007).

Use of RSA as a measure of emotion regulation has led to a new understanding of the physiological processes involved in emotion regulation. Several researchers have demonstrated that RSA levels decrease during stressful or emotional tasks (El-Sheikh et al., 2009; El Sheikh, 2001; Hastings, et al, 2008; Willemen, et al., 2008, Gottman & Katz, 2002). Lower RSA levels indicate that the heart rate has increased and is less in sync with respiration rates in response to a task, indicating that there is lower vagal tone. Other researchers have examined the relationship of an individual's baseline RSA level and his or her observable behaviors during an emotional task and/or parent, teacher, and self-report of externalizing and internalizing behaviors (e.g., Beauchaine et al., 2007; Calkins et al., 2007; Dietrich et al., 2007; El-Sheikh et al., 2009; Forbes et al., 2006; Gottman & Katz, 2002; Greaves-Lord et al., 2007, Hastings et al, 2008; Hinnant & El-Sheikh, 2009; Licht et al., 2009; Watkins et al., 1998). Also, internalizing and externalizing behaviors have been found to have a relationship to RSA reactivity and recovery (the time to return to a baseline level of RSA) during an emotional or stressful task (Beauchaine et al., 2007;

El-Sheikh, 2009; El-Sheikh, 2001; Gottman & Katz, 2002, Musser et al., 2011). In other words, RSA levels and its' link to emotion regulation has been examined primarily in three different ways: high versus low baseline RSA, RSA reactivity in relation to baseline RSA, and RSA reactivity and recovery.

Low baseline RSA has been connected to more externalizing behaviors and emotion dysregulation (Beauchaine et al., 2007; Hinnant & El-Sheikh, 2009). High baseline RSA has been linked to social skills and lower levels of externalizing behaviors (El-Sheikh, 2001). Beauchaine et al. (2007) examined emotion dysregulation in a sample of male children from three age groups. Each participant was assessed with the Child Behavior Checklist (CBCL) and the Adolescent Symptom Inventory (ASI) and DSM-IV criteria to determine if they had Conduct Disorder (CD), Oppositional Defiant Disorder (ODD), and or Attention Deficit Hyperactivity Disorder (ADHD). The participants in the adolescent and middle school group watched an emotion eliciting video. The first study had 59 male adolescents between the ages of 12-17 years, of which 17 had a diagnosis of ADHD, 20 had a diagnosis of conduct disorder, and 22 were controls. This age group watched a video of two males in an escalating conflict that ended with one male pushing the other male. The second study's 40 participants were between the ages of 8-12 years of which 17 had a diagnosis of aggressive ODD and/or CD and 17 were controls. The middle childhood group watched a clip from the video, "The Champ" of a boy watching his father die. The third age group was between the ages of 4-6 years, with 20 (9 girls, 11 boys) controls and 18 (7 girls, 11 boys) children with diagnoses of ODD and ADHD. The results were similar between the adolescent and middle childhood group. Individuals with ODD, and/or CD had attenuated baseline RSA and RSA reactivity while watching the two peers fighting video clip for the adolescents, or "The Champ" for the middle childhood group. The controls had higher baseline RSA and greater RSA reactivity. Consequently, the authors concluded that individuals with lower baseline RSA may be more affected by the RSA reactivity as their system is already compromised. In other words, Beauchaine et al. stated that individuals with a lower RSA baseline may be more affected by the lowering of their overall RSA in that smaller decreases have greater effects on their emotional regulation than those with a higher baseline RSA level. However, the preschool age group did not have attenuated RSA baseline or reactivity. Although the preschool study did include females in the group, the authors concluded that the lack of a group differences was not due to a gender effect.

Research has found that higher levels of RSA during emotion eliciting, stressful, or social tasks are related to lower externalizing and internalizing problems (e.g., Calkins et al., 2007; Hastings et al., 2008). For example, Hastings et al. (2008) measured the baseline RSA and RSA reactivity in children (*n*=94, 54 girls, 40 boys) between the ages of two and four years of age. Hastings et al. measured the child's baseline RSA at his/her home. The participants' mothers completed the Children's Behavior Questionnaire (CBQ) and the CBCL as a measure of internalizing and externalizing behaviors. Between 6-10 months later, the participants' baseline RSA and RSA reactivity was examined during a free play episode in a laboratory playroom with two unknown children who were also participating in the study. The children's mothers were not present in the playroom during the recording period. Using structural equation modeling, the researchers found that children who had higher levels of RSA during the social task (lower RSA reactivity or less RSA change in relation to baseline RSA) had lower externalizing and internalizing problems. Conversely, children's baseline RSA in the home or laboratory setting was not related to internalizing or externalizing problems. The lack of an association in baseline RSA with externalizing and internalizing problems may be further evidence of Beauchaine's et al. (2007) finding that that baseline RSA differences are not evident until middle childhood.

In another study, children with high levels of both externalizing and internalizing behaviors were found to have higher RSA reactivity than children with only externalizing behaviors or healthy controls (Calkins et al. 2007). Calkins' et al. analyzed the RSA levels of 335 5-year olds across five different challenging tasks: (1) an effortful control task, (2) a second effortful control task, (3) an attention persistence task, (4) a positive episode, and (5) a frustration episode. The RSA levels during the challenging tasks were compared to the RSA levels during a baseline episode that preceded the five tasks. The children were divided into three groups based on the parent report on the Child Behavior Checklist; a control group who had scores below 60 on the internalizing and externalizing scales, an externalizing group with scores above 60 on the externalizing scale, and a mixed group with scores above 60 on the internalizing and externalizing scales. An analysis of variance (ANOVA) determined that there were no RSA baseline differences between the control, externalizing, and mixed group. A within subjects ANOVA revealed that the mixed group displayed the greatest RSA reactivity (decreasing RSA) across all tasks, the control group had low RSA reactivity but was not significantly different from the mixed group, and the externalizing group had the least amount of RSA reactivity though it was also not significantly different from the mixed group. Calkins' et al. lack of significant RSA baseline differences are in alignment with Beauchaine's et al. (2007) findings that RSA baseline differences between children with internalizing or externalizing behaviors may not appear until middle childhood. Calkin's et al. findings indicates that even younger children with both high internalizing and externalizing symptoms have greater decreases in their RSA levels in response to a social task in comparison to children with only externalizing or internalizing symptoms or healthy controls.

In contrast to Calkins et al. (2007), a larger amount of RSA reactivity relative to baseline RSA levels) during an emotionally challenging task was found to be a protective factor against externalizing and internalizing behaviors in children of alcoholics (El-Sheikh, 2001).

Conversely, children with lower levels of RSA reactivity (a smaller decrease in RSA levels relative to baseline RSA levels) during an emotionally challenging task had higher levels of externalizing and internalizing behaviors. El-Sheikh (2001) recruited 216 children (n=110 boys, n=156 girls) between the ages of 6-12 years of age from 156 families, of which 75 children were from families that had a history of alcoholism. The methodology used in this particular study included children's baseline RSA being measured for three minutes before two researchers entered the room and enacted a one of two scenarios. One scenario entailed one of the researchers stating that he or she had drunk a large amount of alcohol. The other scenario had the researchers stating that they only drink 7-up. RSA reactivity was measured by subtracting the RSA levels during the scenario from the baseline RSA. Externalizing, internalizing, and social problems were measured by the mother's report on the Personality Inventory for Children, and the teacher's report on the Achenbach Teacher Report Form. Children who had higher levels of RSA reactivity (larger decreases of RSA levels in relation to baseline RSA levels) during the emotion-eliciting task were more likely to have lower parental reports of internalizing or externalizing behaviors. Conversely, children who did not have high levels of RSA reactivity (low decreases of RSA levels in relation to baseline) during the emotion-eliciting task had higher levels of parental report of internalizing or externalizing behaviors.

Further evidence that flexible RSA reactivity is found in healthy controls was found in Musser et al., (2011) study. Children between the ages of 7 and 9 years of age were examined to determine if children with Attention Deficit Hyperactivity Disorder (*n*=32) versus healthy controls (*n*=34) had a physiological response that differed in novel emotion tasks under four conditions that required negative induction, negative suppression, positive induction, and positive suppression. Musser et al. found that overall children with ADHD showed an elevated pattern of RSA activity across tasks while the healthy controls showed a variation in their RSA activity. Healthy controls were more likely to show reduced RSA levels during positive emotion tasks and high levels of RSA levels during negative tasks. Musser et al. concluded in healthy controls that are regulate their emotions have higher levels of RSA during a negative emotion eliciting task but demonstrated lower levels of RSA during positive emotion tasks leading them to conclude that children with ADHD have a different response to positive emotions than children without ADHD. Musser et al.'s findings were similar to Gentzler, Santucci, Kovacs, and Fox's (2009) research findings. In a sample of 65 children, 39 children that had a parent with a childhood onset mood disorder and 29 healthy controls were examined to determine if RSA was predictive of clinical levels of depression and emotion regulation in children. Gentzler et al. (2009) found that in healthy controls, greater RSA decreases were associated with more adaptive emotion regulation. In other words, children between the ages of 5 to 13 years that had greater RSA withdrawal were more adaptive in their responses during a sad film.

A particular note of interest is that most studies have examined internalizing behaviors as a unitary construct, with such symptoms comprised of a cluster of symptoms, such as anxious, depressed, somatic complaints, and withdrawn. Mixed evidence has been found regarding whether individuals with internalizing symptoms have differing RSA levels based on the type of symptoms present; anxious versus depressive symptoms. Accordingly, individuals with internalizing symptoms of anxiety have lower baseline levels of RSA (Greaves-Lord et al., 2007; Watkins et al., 1998). Greaves-Lord et al., (2007) found that children between the ages of 10-13 years with internalizing symptoms of anxiety predicted lower levels of baseline RSA whereas individuals with depressive symptoms did not predict lower levels of baseline RSA. Bosch et al. (2009) also found no significant association between the internalizing symptoms of depression and low levels of baseline RSA in healthy controls. In the clinically depressed group, Bosch et al. actually found a trend for higher levels of baseline RSA to be associated with more depressive symptoms. These findings indicate that anxiety symptoms and depressive symptoms may have different physiological responses that may confuse the interpretation of research findings. In other words, compared to individuals without emotional problems, individuals who have higher levels of depressive symptoms have been shown to have similar or somewhat higher levels of baseline RSA than health controls. Furthermore, individuals with high levels of anxiety symptoms have lower levels of baseline RSA than healthy controls. Nonetheless, when examined along a continuum of level of internalizing behaviors, the research generally supports lower levels of baseline RSA is associated with higher levels of internalizing symptoms experienced in children (Dietrich et al., 2007; Forbes et al., 2006; Greaves-Lord et al., 2007; Hinnant, & El-Sheikh, 2009).

While there is support that both internalizing and externalizing symptoms are inversely related to baseline RSA in children past the preschool years, there was one study that found that children between the ages of 10 and 13 years who exhibited externalizing symptoms had higher levels of baseline RSA (Dietrich et al., 2007). However, overall, the research supports the finding that children with lower levels of baseline RSA have higher levels of internalizing or externalizing symptoms. Children with externalizing symptoms have less RSA reactivity in relation to baseline RSA and those with internalizing symptoms have higher levels of RSA reactivity in relation to baseline RSA. Furthermore, El-Sheikh and colleagues' conclusion that RSA reactivity may serve as a protective factor may also be further evidence of Beauchaine et al. (2007) threshold hypothesis that children with an already compromised emotion regulation system are more affected by smaller changes in reactivity as their baseline RSA was lower than those who did not have externalizing behaviors.

Emotion Regulation Strategies

The strategies one employs to handle his or her emotions is also important in understanding emotion regulation. Gross and Thompson (2007) described five emotion regulation processes, which are: situation selection, situation modification, attentional deployment, cognitive change, and response modulation. Situation selection refers to the process in which the individual engages in a behavior that one expects will increase an experience of a negative or positive emotion. Situation modification, on the other hand, refers to an action that will change the situation directly to influence the emotional experience. Attentional deployment is a strategy in which the individual directs his or her attention away from, or toward an aspect of the situation when the situation is unavoidable. Within this strategy, individuals may use distraction (directing attention away from the emotion eliciting situation) or concentration (directing attention to the emotions of a situation). Another type of strategy is cognitive change, which refers to when an individual changes how he or she views a situation in order to decrease or increase the emotional impact of the situation. The fifth type of strategy is response modulation. Gross and Thompson described response modulation as the process of an individual attempting to regulate the experience, physiological, or behavioral response of an emotion.

Saarni (1999) developed different categories of emotion regulation strategies, which are problem solving, support seeking, distancing or avoidance, internalizing, and externalizing.

Saarni's (1999) descriptions of emotion regulation strategies fall into Gross and Thompson's (2007) category of response modulation. Problem solving is how a child solves a problem to achieve his or her goal. Support seeking strategies are those instances where a child may seek another individual for help or comfort when tasked with a challenging situation. Distancing or avoidance strategies are when a child removes his or herself from a challenging situation. Children who express sadness, worry, anxiety, or blame themselves when a problem occurs are using internalizing strategies. Finally, children who act out aggressively towards another person or object are utilizing externalizing strategies. Consequently, children who have developed emotion regulation strategies that are maladaptive may be utilizing specific types of strategies to an extreme. Children who are inflexible (uses only externalizing strategies or only internalizing strategies) in their emotional response to a social or stressful situation may be indicative of a disorder (Thompson, 1994).

The type of emotion regulation strategies that are accessible and used by children is dependent upon the cognitive and developmental stage of a child (Saarni, 1999). As children grow older, they are able to utilize more and more methods for regulating their behaviors. However, before adolescence, children are generally more likely to rely on one type of strategy than another strategy. Between 5 to 7 years of age, children will tend to seek the support of others to help regulate their emotions. Problem solving during middle childhood (7-10 years of age) is a predominant method for regulating one's behavior (Saarni, 1999). Once a child reaches adolescence, ideally he/she has developed a repertoire of strategies to manage their emotions. Knowing the type of strategies children in middle childhood uses to manage his/her emotions is difficult to determine as children at this age have internalized their language and no longer use egocentric speech. Internalizing and externalizing behaviors have been found to be associated with specific emotion regulation strategies (Liverant et al., 2008; Calkins et al., 1999; Garnefski, et al. 2005; Moore et al., 2008; Supplee, 2009; Shipman, 2003; Tull, 2007; Suveg, 2008; Maughan & Cicchetti, 2002). Research has indicated that individuals with depressive symptoms use response modulation strategies that are aimed at reducing or inhibiting the experience, physiological, or behavioral response of an emotion (Liverant et al. 2008; Shipman, 2003). Individuals with internalizing behaviors tend to also use response modulation strategies that include self-blame and rumination (Garnefski et al., 2005; Moore, 2008, Sarrni, 1999). Individuals with externalizing disorders have been found to use more emotion regulation strategies that include acting aggressively towards others or objects (Calkins, 1999). There is some research examining RSA and emotion regulation strategies. Santucci et al. (2008) found that maladaptive emotion regulation strategies (e.g. displays of anger or sadness and a focus on the delay of reward) were associated with lower RSA levels. Researchers primarily examine emotion regulation in relation to emotion regulation strategies or emotion regulation in relation to RSA but not both.

Measuring Emotion Regulation

There are several methods used to measure emotion regulation and emotion regulation strategies in children such as behavioral rating scales, physiological measures, and behavioral observations. As noted above, RSA is the primary physiological measure used in emotion regulation research. RSA is used as an indirect measure of the parasympathetic nervous system via the vagus nerve and of emotion regulation (Porges, 2007; Porges, 2003; Porges, 2001; Porges, 1998; Porges, 1995). To measure RSA, one examines heart rate variability in relation to the rate of spontaneous/natural breathing (Porges, 2007). However, other researchers have stated that respiration rate and tidal volume (amount of air taken in) affect the magnitude of RSA (see Grossman, & Taylor, 2007, for a more in-depth review). Essentially, individuals who are breathing shallowly and rapidly have lower RSA levels and those who are breathing deeply and slowly have higher levels of RSA. Grossman and Taylor (2007) stated that researchers need to understand the effects of breathing in order to understand within individual or between individual changes in RSA by measuring tidal volume and heart rate variability. Researchers have used a variety of laboratory tasks to examine RSA reactivity, such as emotion eliciting tasks that include watching a sad or angry film, listening to or watching an argument between peers or adults, encountering frustration (withholding a reward or engaging in a cognitive task), and engaging in positive and negative interactions with adults (e.g., Beauchaine et al., 2007; El-Sheikh, 2001; Simonds et al., 2007).

Commonly, behavioral rating scales ask a rater such as a parent or teacher to respond to a variety of questions about an individual's behavior. The most commonly used measures have been the Achenbach Child Behavior Checklist (CBCL) (Achenbach & Rescorla, 2001) or the Personality Inventory for Children (Lachar & Gruber, 2001). However, the Behavior Assessment System for Children-2nd edition (BASC-2; Reynolds & Kamphaus, 2004) is commonly used in the school context and has similar scales for internalizing and externalizing symptoms. Additionally, the BASC-II is conducive to multiple informants as it has a parent and self-report measure that starts at 8 years of age (BASC-2; Reynolds & Kamphaus, 2004). Physiological measures may include heart rate, RSA, and skin conduction or saliva analysis of cortisol levels. Finally, many researchers utilize behavior observations to analyze emotion regulation. Behavior observations involve directly observing a child and coding the behaviors seen according to a set of parameters established by literature or theory.

Projective techniques are used to measure underlying cognition and emotions that are not tapped into with objective techniques (Sattler & Hodge, 2006). Due to the ambiguous nature of the stimuli and the purpose of the test being less discernible to examinees, faking or lying on such a measure is difficult. Sattler and Hodge stated that projective techniques should not be used in isolation but as part of a battery of assessment to discern information about an individual's personality. Much caution is necessary when utilizing projective techniques, as administration and scoring are not commonly standardized and often have low inter-rater reliability and validity. Consequently, projective techniques have not been used as a measure of emotion regulation and strategies in current research. In spite of the caution in using projective techniques, the information gathered about the underlying processes and strategies may offer unique insight into the process of how children with varying levels of externalizing and internalizing behaviors solve and view problems. The Roberts-2 (Roberts & Gruber, 2005) is a standardized projective measure that contain scales that measure how individuals solve problems, seek resources to support them, and emotions associated with problems which are strategies that are parallel to those suggested by Gross and Thompson (2007) and Saarni (1999).

Summary and Conclusions

In summary, there is evidence that baseline RSA levels are inversely related to internalizing and externalizing symptoms. Additionally, there is empirical support that smaller decreases in RSA reactivity in relation to baseline RSA levels during emotion eliciting tasks are related to externalizing behaviors and larger decreases are related to internalizing behaviors. There is a paucity of literature on the role that emotion regulation strategies has in baseline RSA levels and RSA reactivity, though one study indicated that maladaptive emotion regulation strategies are related to lower RSA levels. Given the complexity of the relationship between emotion regulation and RSA, the purpose of this study is to examine how RSA is affected across paced breathing, attention, inhibition, and emotion eliciting tasks and how those relationships may be mediated by emotion regulation strategies in children with different levels of externalizing and internalizing behaviors between the ages of 8 and 12 years.

CHAPTER THREE: METHOD

Participants

Children between 8 and 12 years of age were recruited because children this age are beyond the early childhood years, but typically have not yet begun puberty. Research has indicated that children in the preschool years who are at-risk for externalizing behaviors do not show RSA group differences, but RSA group differences appear sometime between the preschool years but before middle childhood years (Beauchaine et al., 2007). The middle school years are generally considered to be between 6 and 13 years of age. Due to the wide range of ages and developmental stages of children, a narrower age range for this study was recruited to decrease confounding results due to development and maturity of the child. A target sample size of 40 was recruited as a sample size of 36 was calculated using G*Power, version 3.1 with the parameters of 3 predictors (internalizing scores, externalizing scores, and RSA natural baseline), medium effect size of 0.35, $\alpha=0.05$, and power was set at 0.80. Participants were recruited from a suburban southwest city by distributing flyers to local area school psychologists, parents, and teachers. A total of 49 participants were contacted and initially recruited by a research team member to screen for eligibility. Exclusionary criteria included children with a formal diagnosis of Attention Deficit/Hyperactivity Disorder or a cognitive impairment that limited their ability to complete the experimental tasks. After initial contact, 10 individuals declined participation due to time constraints and 3 participants withdrew after consenting because (1) one was out of age range (13 years) before completing the first session; (2) one withdrew after two appointments had to be rescheduled due to lab being locked; and (3) one withdrew from the study due to not wanting to complete the study. Finally, three participants completed the study but had unusable ECG data. A total of 31 participants had complete data and were used in all subsequent analyses.

The final sample included 31 children (14 males, 17 females). The children's ages ranged from 8.3 to 12.7 (M = 10.48, SD = 1.3) at time of initial visit. The racial background of the child participants were 51.6% (n = 16) Mexican-American, 38.7% (n =12) Caucasian, 3.2% (n = 1) African American, and 3.2% (n = 1) Asian. In terms of reported annual household income, 77.4% (n =24) of the parents reported an income of $50,000 or more, 3.2% ($n$ = 1) had an income of $40,000 or more, 6.5% ($n$ =2) had an income of $30,000 or more, 6.5% ($n$ = 2) had an income of $20,000 or more, and 6.5% (n = 2) had an income of less than $5000.

Measures

The Behavior Assessment System for Children-Second Edition (BASC-2). The BASC-2 was used to assess the level of internalizing and externalizing behaviors. The BASC-2 provides a comprehensive set of behavior rating scales that gather information from a variety of sources including the Parent Rating Scales and a Self-Report of Personality (BASC-2; Reynolds & Kamphus, 2004). The BASC-II Parent Rating Scales for children between the ages of 6 to 11 years was standardized on a norm group of parents of 1,800 children. The norm group for the Self-Report consisted of 1,500 children between the ages of 8 to 11 years of age. The sample characteristics matched the U.S. Census data from 2001 for age, gender, and ethnicity. Internal consistency reliabilities for the Parent Rating Scales ranged from .70 to.88 and .67 to.90 for the Self Report of Personality Scales. The BASC-II has three scales, the primary scales, content scales, and composite scales. For the purposes of this study, the scores from the Parent Report Scales on the Composite scales of Externalizing and Internalizing problems were used for analysis. The scores from the Self Report of Personality Scales included the scores from the Composite scales of Internalizing Problems and Emotional Symptom Index (externalizing score). All scores are reported as *T*-scores with a mean of 50 and standard deviation of 10. Each score was entered as a continuous variable.

The BASC-2 scales measure a wide range of behaviors related to Diagnostic Statistical Manual-IV classification and Individual Disability Education Act categories. The Parent Rating Scales measure adaptive and problem behaviors in the community and home setting between the ages of 2-21 years of age. The form has 160 questions at about the fourth grade reading level and takes 10-20 minutes to complete. The Self-Report of Personality provides insight into a child's thoughts and feelings with 139 questions that takes about 30 minutes to complete. Each rating and self-report form includes a validity scales to determine the quality of the completed form.

Each question or behavior is rated on a four-point scale of frequency, ranging from "Never" to "Almost Always." Responses are inputted into a computer software program that calculates the BASC-II scores in t-scores. T-scores between 60 and 70 are considered to be in At-Risk range while scores 70 and above are considered to be in the Clinically Significant range except on the Adaptive Scales. For the Adaptive Scales, scores between 40 and 30 are considered to be in the At-Risk range and scores 30 and lower are considered to be in the Clinically Significant range. While the Child Behavior Checklist is more commonly used in research, it does not provide a self-report form for children between the ages of 8-12 years. Therefore, the BASC-II Self-Report and Parent Report forms was utilized for this study.

For purposes of this study, the Parent Report Internalizing Composite and Self-Report Internalizing Composite were used as the primary indicators of internalizing symptoms and Parent Report Externalizing Composite and Self-Report Hyperactivity/Inattention Composite were used as the primary indicators of externalizing symptoms.

Roberts Apperception Test-Second Edition 2 (Roberts-2). The Roberts-2 was used to assess emotion regulation strategies. The Roberts-2 provides information about the child or adolescent's expression of social understanding (Roberts & Gruber, 2005). The test was standardized and normed on non-referred children and adolescents with demographic characteristics that correspond to the national population. The standardization sample consisted of 1,060 individuals between the ages of 6-18 years of age. A clinical sample was also included in the norming and standardization process of the Roberts-2. The clinical sample had 595 individuals between the ages of 6-18 years of age that were from a variety of clinical and special education settings. Parental education level and socioeconomic status, gender, geographic region, and ethnicity were also represented in the standardization sample comparable to levels present in the national sample from the 2004 U.S. Census data.

The Roberts-2 provides information about how a child or adolescent perceives social situations, accesses resources to deal with problem feelings, and solves conflicts. Information is provided about the tendency for the examinee to include emotional content related to anxiety, aggression, rejection, and depression as well as information about the tendency of the individual to provide narrative content that indicates perception that is atypical or unusual. The Roberts-2 involves showing the child 16 different cards that depict everyday social events that may be part of children's and adolescents lives (Roberts & Gruber, 2005). The child is then asked to create a narrative about the story that tells what happened before the picture, during the picture and how the story ends. Additionally, the child is instructed to tell who the people are, what they are thinking, doing, and feeling.

The Roberts-2 has 7 sections with 28 scales with each section having between 2 to 6 scales. The 7 sections are: *Theme Overview Scales*, *Available Resources Scales*, *Problem*

Identification Scales, *Resolution Scales, Emotion Scales, Outcome Scales*, and *Unusual or Atypical Responses*. The *Theme Overview Scales* provide information about how a child perceives common social situations. The *Available Resources Scales* indicate the type of resources that individuals tend to access when dealing with problem feelings and situations. The *Problem Identification Scales* provide information about how an individual identifies a problem and has insight into the problem. The *Emotion Scales* provide information about how an individual is doing in the areas of Anxiety, Aggression, Depression and Rejection. A high score on one of these areas does not necessarily indicate that the individual is depressed or has anxiety but does indicate that the individual may be having some difficulty in that area. The *Resolution Scales* provide information about how an individual tends to solve a conflict or a problem. The *Outcome Scales* indicate if an individual is unable to solve a problem constructively. This subscale has four sections, which are unresolved, non-adaptive, maladaptive, and unrealistic. Finally, the *Unusual or Atypical Responses* are responses that may include but is not limited to content that include antisocial behavior, illogical thought processes, death or dying, and/or abuse.

There are no internal consistency reliabilities or construct or criterion related validity studies reported for the Roberts-2 (Roberts & Gruber, 2005). Inter-rater reliabilities were reported between .43-1.00. For the purpose of this study, two trained graduate researchers scored the same 10 Roberts' responses to obtain an inter-rater reliability rating. A licensed psychologist determined the final scoring on any discrepant scores. The following scores will be utilized for analysis of emotion regulation strategies: the *Available Resources Scales*, The *Problem Identification Scales*, the *Resolution Scales*, *The Emotion Scales* and *Outcome Scales*. The Available Resources Scales include the Support Self-Feeling (α=.78), Support Self-Advocacy (α=.92), Support Other-Feeling (α=.86), Support Other-Help (α=.92), Reliance on Other (α=.93), and Limit Setting (α=.85). The Problem Identification Scales include: Problem Identification-Recognition (α=.91), Problem Identification Description (α=.64), and Problem Identification (α=.89). The Resolution Scales include: Resolution 1 (α=.79), Resolution 2 (α=.89), and Resolution 3 (α=.94). The Emotion Scales include: Anxiety (α=.87), Aggression (α=.96), Depression (α=.96), and Rejection (α=.88). The Outcome Scales include: Unresolved (α=.91), Nonadaptive (α=.93), Maladaptive (α=.91), and Unrealistic (α=1.00). All scores are reported as T-scores with a mean of 50 and standard deviation of 10.

Respiratory sinus arrhythmia. Respiratory sinus arrhythmia (RSA) is heart rate variability in synchrony with respiration. Each participant had his or her electrocardiography (EKG) recorded. The EKG was measured using disposable electrodes in a standard Lead II formation. Heart rate (HR) was calculated from inter-beat (RR) interval. RSA was then calculated from the data obtained from the electrodes and respiratory readings that were obtained through inductive plethysmography band placed around the chest. Using laboratory software, MindWare HRV 2.6, RSA averages were computed for baseline, paced-breathing, attention, inhibition, and emotional reactivity tasks. Comparisons were made to determine if baseline or natural breathing were more effective in statistical analysis.

Paced breathing. After attaching the physiological sensors, the participant was instructed to listen to a soft tone that rises and falls in pitch. The participant was instructed to breathe in when the tone is rising in pitch and to breath out when the tone is falling in pitch. The tone will be designed to create a respiratory frequency of 9 cycles per minute for two minutes (Butler et al., 2006).

Attention task. Each participant was administered the Cancellation subtest from the Wechsler Intelligence Scale for Children, 4th edition (Wechsler, 2003). The subtest requires the participant to look at 2-page spread of colorful pictures and cross through the pictures of animals. Examples of the pictures include objects that are a hat, flashlight, and saw and examples of the animals include cows, bears, and dogs. There are two parts to Cancellation: structured and random. The structured form has the pictures in horizontal rows whereas the random form has the pictures haphazardly scattered throughout the two pages. This subtest is a supplemental subtest for Processing Speed. Cancellation measures a variety of cognitive functions some of which are visual short-term memory, fine-motor coordination, attention, concentration, processing speed, perceptual speed, visual-motor coordination, and visual processing.

Cancellation has a reliability score of .79 with reliability coefficients that range between .73 to .84. This task lasted for about three minutes.

Self-regulation task (inhibition). Each participant was administered the Stroop Color and Word Task-Children's Version for ages 5-14 years which has three different tasks (Golden, Freshwater, & Golden, 2003). The first task is to read a list of words as quickly as one can for 45 seconds. The second task is to identify the colors of abstract, meaningless symbols as quickly as he or she can in 45 seconds. And the third task is to read a list of color words written in non-matching color ink as quickly as one can in 45 seconds. This task has been commonly used as a measure of one's ability to inhibit a response (Inzlicht & Gutsell, 2007; Golden & Golden, 2002). The ability to choose between two competing responses is considered a function of self-regulation (Ellis, Rothbart, & Posner, 2004). The Stroop Test has noted that greater scores occur as inhibitory control increases in children between the ages of 7 to 13 years (Golden et al., 2003). Test-retest reliability has been reported as .90 for word reading task, .83 for the color naming task, and .91 for the color-word interference task (Spreen & Strauss, 1998). Scores are reported as t-scores with a mean of 50 and a standard deviation of 10.

Emotional reactivity task. The participant participated in two emotion-eliciting tasks. Each individual watched a brief film depicting an emotionally arousing situation. The participants was shown a 3-minute clip of "The Champ," which has been used to elicit feelings of sadness and empathy by researchers in children (Beauchaine et al., 2007; Gross & Levenson, 1995). The clip shows a child who becomes inconsolable while he watches his father die from injuries during a boxing match. The second emotion-eliciting task was a 3-minute clip showing a scene from “My Bodyguard”, which has been used to elicit feelings of anger by researchers, though not with children (Gross & Levenson, 1995). The clip shows two boys fighting in a group of onlookers with one of the boys being a bully.

Neutral emotion task. After each task including the attention and stress regulation (inhibition) tasks, the participant was shown neutral 3-minute film clips. The 3-minute clips were from popular animated films such as, “Finding Nemo.”

Procedures

Approval was first obtained from the University of Arizona, Institutional Review Board. Informational flyers were then distributed to local school psychologists, teachers, or by word of mouth to give or mail to potential participants. The informational flyers had information detailing how a potential participant and his/her parent may contact the researcher to enroll in the study. Interested participants were screened for indicators of Attention Deficit Hyperactivity Disorder by requesting a waiver of consent for screening. The information was destroyed for those individuals who completed the screening but did not participate in the research study. After the completion of data collection, each individual received a participant identification number and all identifying information was destroyed.

Research was conducted over the course of two sessions that occurred in back to back sessions or scheduled at times that were convenient for the participant. The participant was administered the Robert's 2 and the Behavior Assessment System for Children, 2nd edition Self-Report of Personality (BASC-II-SRP) by the present author or a trained research team member. During this same visit, the parent of the child was given the Behavior Assessment System for Children, 2nd edition, Parent Report (BASC-II-PR). The purpose of this session was to gather information about the child's social and emotional functioning. These sessions lasted approximately 1.5 hours.

In a concurrent session or separate session that lasted approximately 1 hour, the participant was engaged in structured tasks with an examiner while his or her RSA was continuously recorded. All participants completed five separate tasks during this session in the same order: baseline (3 minutes), paced breathing (2 minutes), attention task (4 minutes), an inhibition task (4 minutes), the sad film (3 minutes), and anger film (3 minutes). In between each task, the child had a recovery period where he or she watched 3 minute clips of a neutral film. The recovery period was to prevent carryover effects of a prior task. The participant received compensation for his/her part in the study by selecting a prize from a "goody bag" at the end of the first session and a $10 gift card at the completion of the second session.

Data Analyses

First, basic sample characteristics (sex, race/ethnicity, SES, etc.) were examined in relation to the emotional and behavioral measures using the Pearson product-moment correlation. All analysis used an $\alpha=0.05$ for statistical tests of significance. Preliminary analyses were conducted to ensure no violation of the assumptions of normality, linearity, multicollinearity, and homoscedasticity. A hierarchical multiple regression model was utilized for analysis as it allows for a prediction of one variable (RSA) based on the knowledge of another variable (Internalizing and Externalizing scores) while controlling for a third variable (paced or natural breathing RSA levels). Based on the steps outlined by Baron and Kenny (1986) potential mediation effects of emotion regulation strategies were examined in a multiple regression analysis (aim 3).

Aim 1. A multiple regression model was used to analyze the result for the first aim of the study, which is to determine whether internalizing and externalizing symptoms are more predictive of RSA levels using a paced breathing method or a spontaneous breathing method.

RSA paced breathing = Externalizing scores + Internalizing Scores

RSA natural breathing = Externalizing scores + Internalizing Scores

Based on the outcome, RSA paced breathing or RSA natural breathing was used as the indicator of baseline RSA in the primary analyses for Aims 2 and 3.

Aim 2. The. Pearson product-moment correlations and a series of four regression models were used to address the following hypothesis.

Hypothesis 2a: As levels of externalizing behaviors increase, children's levels of baseline RSA will decrease.

A correlation between baseline RSA and the BASC Parent Report Externalizing Composite and Self-Report Hyperactivity/Inattention composite was obtained.

Hypothesis 2b: As levels of internalizing behaviors increase, children's levels of baseline RSA will decrease.

A correlation between baseline RSA and the BASC Parent Report Internalizing Composite and Self-Report Internalizing Composite was obtained.

Hypothesis 2c: There will be significantly less change in RSA levels relative to RSA baseline levels (lower RSA reactivity) as the level of externalizing behaviors increases.

First, correlations were obtained to determine the relations between RSA levels during each of the task conditions and the two BASC composites evaluating externalizing symptoms. Then, a hierarchical multiple regression was run whereby baseline RSA was entered as the first step (step 1) followed by the four BASC scales (1) Parent Report

Externalizing composite, (2) Parent Report Internalizing Composite, (3) Self-Report Internalizing Composite, and (4) Self-Report Hyperactivity/Inattention Composite measuring externalizing and internalizing symptoms.

Hypothesis 2d: As children's levels of internalizing symptoms increase, there will be significantly larger changes in RSA levels relative to RSA baseline levels (RSA reactivity).

First, correlations were obtained to determine the relations between RSA levels during each of the task conditions and the two BASC composites evaluating externalizing symptoms. Then, a hierarchical multiple regression was run whereby baseline RSA was entered as the first step (step 1) followed by the four BASC scales (1) Parent Report Externalizing composite, (2) Parent Report Internalizing Composite, (3) Self-Report Internalizing Composite, and (4) Self-Report Hyperactivity/Inattention Composite measuring externalizing and internalizing symptoms.

1) RSA (attention) = Step 1: RSA natural breathing baseline

Step 2: Externalizing + Internalizing

2) RSA (inhibition) = Step 1: RSA natural breathing baseline

Step 2: Externalizing symptoms + Internalizing symptoms

3) RSA (sad film) = Step 1: RSA natural breathing baseline

Step 2: Externalizing + Internalizing

4) RSA (anger film) = Step 1: RSA natural breathing baseline

Step 2: Externalizing + Internalizing

The third aim of the study is to investigate how emotion regulation strategies may mediate the relationship between baseline RSA and RSA reactivity in children with varying levels of externalizing and internalizing behaviors. As this aim is exploratory, a hypothesis was not developed. In fact, there is very limited research that examined mediating effects of emotion regulation strategies on the relationship between externalizing and internalizing symptoms and RSA baseline and reactivity. The following scores from the Robert-2 were used for the analysis: Available Resources Scales, Problem Identification Scales, Resolution Scales, and the Outcome Scales. Each of these scales is reported as a T-score. In other words, if internalizing and externalizing behaviors are significantly predictive of RSA during any of the tasks relative to baseline RSA, then the mediating relationship of emotion regulation strategies can be examined for that significant result (see Figure 1).

The first step was to determine if the pathway from externalizing or internalizing levels to emotion regulation strategies is significant for each significant result from the second set of research questions. The second step was to determine if the pathway from emotion regulation strategies to the RSA change score is significant. The third step was to examine if the pathway from externalizing or internalizing scores to RSA change score is a significantly altered based on a mediating effect of emotion regulation strategies. The third research aim was primarily designed to examine emotion regulation strategies as a mediating factor on the relationship between externalizing or internalizing scores and RSA using multiple regression analyses. However, regardless of outcomes of the second aim, relationships between internalizing and externalizing behaviors and emotion regulation strategies were examined. Additionally, the relations between emotion regulation strategies and RSA were examined.

RSA (significant results) = Externalizing or Internalizing scores + Regulation Strategies + RSA natural breathing

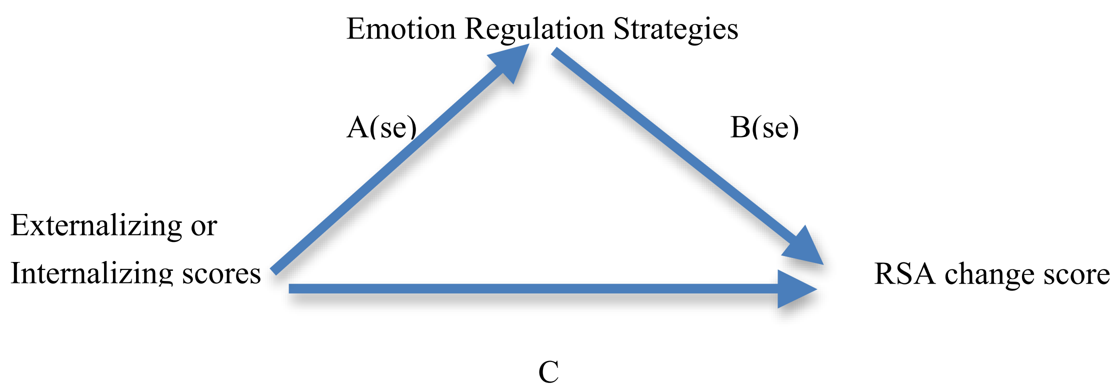

Figure 1. Meditational pathway of emotion regulation strategies

CHAPTER FOUR: RESULTS

Preliminary Analysis

Initial analyses examined if RSA during each task, BASC II Parent Report and Self Report scales, Stroop and Cancellation T-scores were related to age, sex, and race/ethnicity to determine if these demographic variables needed to be controlled for in the models. However, no variables were significantly related to child's age, child's sex, or race/ethnicity and were not considered in further analysis. Additionally, based on visual inspection of the RSA values using histograms with normal probability plots, RSA values during the attention, inhibition, and anger tasks were log transformed due to skewed data as well as one participant's RSA score during the attention task was removed from data analysis as the score was considerably outside the range of the other variables. One participant's RSA data during the anger task was also removed, as the data were unreadable.

Research Aim 1. The first research aim was to determine whether or not internalizing and externalizing behaviors were more predictive of RSA levels when using a paced breathing method or a natural breathing method. The hypothesis was that *internalizing and externalizing behaviors would be more predictive of RSA baseline levels when utilizing a paced-breathing method of measuring RSA*. Bivariate correlations between BASC II Parent Report Internalizing Composite and Externalizing Composite scores and RSA Paced Breathing or Natural Breathing were not significant (see Table 1). Additionally, bivariate correlations between BASC II Self-Report Internalizing Composite and Hyperactivity/Inattention composite and RSA Paced Breathing or Natural Breathing were not significantly correlated. For subsequent analysis, RSA levels during the natural breathing tasks were used as a control variable for hierarchical multiple regression analysis as this is consistent with Porges' (2007) conceptualization of RSA.

Table 1

Summary of Correlations, Means, and Standard Deviations for T-scores on BASC II Parent Report and RSA scores.

BASC II Parent Scales	PB n =31	NB n =31	Attention n =31	Inhibition n =30	Sad n =31	Anger n =30
Externalizing	-.05	.02	-.01	-.13	-.04	.38*
Hyperactivity	-.16	-.08	-.25	-.19	.00	.40*
Aggression	.07	.01	-.06	-.16	-.09	.17
Conduct Problems	-.02	.12	-.16	-.02	-.07	.44*
Internalizing	-.06	-.06	-.04	-.43*	-.16	.37
Anxiety	-.11	-.17	-.09	-.46*	-.16	-.19
Depression	-.13	-.02	-.12	-.39*	-.11	.15
Somatization	.14	.01	-.04	-.17	-.01	.25
M	9.11	7.90	.94	.92	7.18	.88
SD	1.27	1.46	.11	.09	1.41	.07

Note. RSA scores were log transformed for Attention, Inhibition and Anger task.
Sample sizes differ slightly based on missing items for RSA tasks.
$*p < 05$.

Research Aim 2. To determine if performance on an attention or inhibition task correlated with RSA levels and thus needed to be considered as a control variable, bivariate correlations among RSA scores and the Stroop task and Cancellation tasks are shown in Table 2. There were no significant correlations between performance on the Stroop (T-scores) and RSA levels during this task. There also were no significant correlations between the Cancellation scores and RSA levels during that task. Therefore, no further analyses were conducted using the Stroop T-scores or the Cancellation scaled scores and RSA levels.

Table 2

Summary of Correlations, Means, and Standard Deviations for scores on Stroop, Cancellation and RSA scores.

Measure	PB n =31	NB n =31	Attention n =31	Inhibition n =30	Sad n =31	Anger n =30	*M*	*SD*
Stroop Word	-.08	.14	-.09	.01	.18	.06	57.62	7.79
Color	-.06	.08	-.15	-.03	-.01	.13	49.03	5.86
Color Word	.04	.02	-.26	-.27	.28	.24	48.21	7.57
Interference	-.09	.08	.03	.20	-.27	-.07	49.75	7.81
Cancellation	.03	-.20	.04	.17	.02	-.01	9.45	2.95
M	9.11	7.90	.94	.92	7.18	.88		
SD	1.27	1.46	.11	.09	1.41	.07		

Note. RSA scores were log transformed for Attention, Inhibition and Anger task.
Sample sizes differ slightly based on missing items for RSA tasks.
**p* < 05, ** *p* < .01.

Research Aim 2a. Part of Aim 2 was to examine how baseline RSA levels are a function of internalizing and externalizing behaviors. Contrary to the hypothesis that as *externalizing levels increase, baseline levels of RSA levels decrease*, there were no significant correlations between RSA levels during paced or natural breathing tasks and the Parent Report BASC II Externalizing Composite (See Table 2). In addition to parent report measures, self-report measures were also examined. The Hyperactivity/Inattention composite was not significantly correlated with RSA levels during a paced breathing or natural breathing task (See Table 3).

Table 3

Summary of Correlations, Means, and Standard Deviations for T-scores on BASC II Self-Report and RSA scores.

BASC II-Self-Report Scales	PB n =31	NB n =31	Attention n =31	Inhibition n =30	Sad n =31	Anger n =30
Hyperactivity/Inattention	-.14	.00	-.46**	-.34	-.09	.27
Hyperactivity	-.08	-.03	-.38*	-.29	.08	.29
Attention	-.18	.02	-.51**	-.40*	.10	.24
Internalizing Composite	-.24	.12	.31	-.35	-.02	-.08
Atypicality	-.24	.16	-.15	-.18	-.05	.08
Locus of Control	-.17	.26	-.23	-.35	-.02	-.04
Social Stress	-.22	.07	-.31	-.41*	-.02	-.09
Anxiety	-.15	-.13	-.29	-.18	-.09	-12
Depression	-.28	.04	-.34	-.44*	.05	-.12
Sense of Inadequacy	-.33	-.01	-.37*	-.25	-.00	.03
M	9.11	7.90	.94	.92	7.18	.88
SD	1.27	1.46	.11	.09	1.41	.07

Note. RSA scores were log transformed for Attention, Inhibition and Anger task.
Sample sizes differ slightly based on missing items for RSA tasks.
*p < 05, ** p < .01.

Research Aim 2b. Contrary to the hypothesis that *as internalizing levels increased, baseline levels of RSA levels decrease,* there were no significant correlations between RSA Parent Report BASC II Internalizing Composite and RSA levels during paced or natural breathing tasks (see Table 2). Additionally, the Self Report BASC II Internalizing composite and RSA levels paced and natural breathing tasks were not correlated (See Table 3).

Research Aim 2c. Another aim was to examine how RSA changed in relation to baseline RSA levels during an attention, inhibition, and emotion-eliciting tasks (sad and anger) are a function of parent and self-report of externalizing and internalizing behaviors. The hypothesis was that there would be *significantly less change in RSA levels relative to RSA baseline levels* *(lower RSA reactivity) as the level of externalizing behaviors increases*. The Parent Report BASC II Externalizing composite was significantly positively correlated with RSA levels during the Anger condition, r (n = 30) = .38, p = .036, meaning that higher scores on the Externalizing Composite were correlated with higher levels of RSA during an anger task indicating higher levels of emotional regulation. No other significant correlations were found between the Parent Report BASC II Externalizing composite and RSA during attention, inhibition, and sad tasks (See Table 2.) In regards to the externalizing behaviors for the self-report measures, scores on the Hyperactivity/Inattention composite were significantly negatively correlated with RSA levels during an Attention tasks, r (n = 31)= -.462, p = .009. No other significant correlations were found between the Self-Report BASC II Hyperactivity/ Inattention composite and RSA during inhibition, anger, and sad tasks (See Table 3.)

Research Aim 2d. Another aim was to examine how RSA changes in relation to baseline RSA levels during an attention, inhibition, and emotion eliciting tasks (sad and anger) are a function of parent and self-report of externalizing and internalizing behaviors. The hypothesis was that there would be *significantly more change in RSA levels relative to RSA baseline levels (higher RSA reactivity) as the level of internalizing behaviors increases*. The Parent Report BASC II Internalizing composite and RSA levels during the Inhibition task were significantly negatively correlated, r (n = 30)= -.43, p = .019, meaning that lower levels of internalizing behaviors were correlated with higher levels of RSA levels during an Inhibition task. No other significant correlations were found between the Parent Report BASC II Internalizing composite and RSA during attention, anger, and sad tasks (See Table 2.) Additionally, the Self-Report BASC II Internalizing composite was not significantly correlated with RSA during attention, inhibition, sad, and anger tasks (see Table 3).

Hierarchical Multiple Regression Analyses

A series of hierarchical multiple regression analysis were conducted to in order to examine how RSA levels during an attention, inhibition, and emotion eliciting tasks (sad and anger) are a function of parent and self-report of externalizing and internalizing behaviors when controlling for baseline RSA levels during a natural breathing task. The following variables were included in the final model: RSA during a natural breathing task (step 1), Parent Report Internalizing Composite, Parent Report Externalizing Composite, Self-Report Internalizing Composite, and the Self-Report Hyperactivity/Inattention Composite.

Natural breathing and RSA during attention task. In the first model, RSA levels during an Attention task was an outcome in hierarchical multiple regression. Natural Breathing RSA levels were entered in Step 1 and contributed 3.5% of the variance. When Parent Report Internalizing, Parent Report Externalizing, Self-Report Internalizing, and Self Report Hyperactivity/Inattention composites were entered at Step 2, the total variance explained by the model was 27%, F (5, 25) = 1.86, p = .13 (see Table 4.). Although the overall model was not significant, there was a trend for the Self Report Hyperactivity/Inattention composite (β = -.63, b = -1.75, p = .09) contributing most of the variance.

Table 4

Hierarchical Multiple Regression Analysis Predicting RSA levels during an Attention Task controlling for RSA levels during natural breathing task

Predictor	RSA Attention	
	ΔR^2	ß
Step 1	.03	
Natural Breathing		
Step 2	.24	
PRS Internalizing Composite		.05
PRS Externalizing Composite		.15
SR Internalizing Composite		.08
Hyperactivity/Inattention Composite		-.63
R^2	.27	
n	31	

Note. RSA scores were log transformed for Attention tasks.
$^*p \leq 0.05$, $^{**}p \leq 0.01$.

Natural breathing and RSA during inhibition task. In the second model, RSA levels during an Inhibition task were the outcome in a hierarchical multiple regression. Natural Breathing RSA levels were entered in Step 1 and contributed 0.4% of the variance. When Parent Report Internalizing, Parent Repot Externalizing, Self-Report Internalizing, and Self Report Hyperactivity/Inattention composites were entered at Step 2, the total variance explained by the model was 28%, F (5, 24) = 2.32, p = .08 (see Table 5). Thus, although not significant, there was a trend for internalizing and externalizing symptoms to predict RSA levels during an Inhibition task , with Parent Report Internalizing Composite (β = -.45, b = -2.10, p =.04) contributing most of the variance. The Parent Report Externalizing Composite (*β* = -.31, *b* = -1.23, *p* = .22), Self-Report Internalizing Composite (*β* = .12, *b* = .37, *p* = .71), and Self-Report Hyperactivity/Inattention (*β* = -.49, *b* = -1.35, *p* = -.18) contributed minimally to the overall model.

Table 5

Hierarchical Multiple Regression Analysis Predicting RSA levels during an Inhibition Task controlling for RSA levels during a natural breathing task

Predictor	RSA Inhibition	
	Δ R^2	ß
Step 1	.004	
Natural Breathing		
Step 2	.27	
PRS Internalizing Composite		-.45 *
PRS Externalizing Composite		.31
SR Internalizing Composite		.12
Hyperactivity/Inattention Composite		-.49
Total R^2	.28	
n	31	

Note. RSA scores were log transformed for an Inhibition task
$^*p \leq 0.05$, $^{**}p \leq 0.01$.

Natural breathing and RSA during sad task. In the third model, RSA levels during a Sad task were the outcome in hierarchical multiple regression. Natural Breathing RSA levels were entered in Step 1 and contributed 16% of the variance. When Parent Report Internalizing, Parent Report Externalizing, Self-Report Internalizing, and Self-Report Hyperactivity/Inattention composites were entered at Step 2, the total variance explained by the model was 27%, F (5, 25) = 1.91, p = .12 (see Table 6). Despite the moderate effect, the model was not significant and none of the predictors contributed significantly to the overall model. The Self-Report

Hyperactivity/Inattention Composite (*β* = .66, *b* = 1.84, *p* = .007) contributed significantly but the other variables did not significantly contribute to the overall model.

Table 6.

Hierarchical Multiple Regression Analysis Predicting RSA levels During a Sad Task Controlling for RSA Levels During a Natural Breathing Task

Predictor	RSA Sad	
	Δ R^2	ß
Step 1	.16	
Natural Breathing		
Step 2	.12	
PRS Internalizing Composite		.004
PRS Externalizing Composite		-.28
SR Internalizing Composite		-.51
Hyperactivity/Inattention Composite		.66
Total R^2	.27	
n	31	

Note. **p* ≤ 0.05, ***p* ≤ 0.01.

Natural breathing and RSA during an anger task. In the final model, RSA level during an Anger task was the outcome in hierarchical multiple regression. Natural Breathing RSA levels were entered in Step 1 and contributed 4% of the variance. When Parent Report Internalizing, Parent Report Externalizing, Self-Report Internalizing, and Self-Report Hyperactivity/Inattention composites were entered at Step 2, the total variance explained by the model was 47%, *F* (5, 24) = 4.39, *p* = .006). The Self Report Internalizing Composite (*β* = -.96, *b* = -3.38, *p* = .002) and Self-Report Hyperactivity/Inattention Composite (*β* = .93, *b* = 2.97, *p* = .007) both added their own unique variance to the prediction of RSA levels during an anger task (see Table 7). Thus, after controlling for baseline RSA allowing RSA levels during anger to reflect reactivity, as the Self-Report Internalizing Composite scores increased, RSA levels during an anger task decreased and as Self Report Hyperactivity/Inattention Composite scores increased, RSA levels during the anger tasked also increased.

Table 7

Hierarchical Multiple Regression Analysis Predicting RSA levels During a Anger Task Controlling for RSA Levels During a Natural Breathing Task

Predictor	RSA Anger	
	Δ R^2	ß
Step 1	.06	
Natural Breathing		
Step 2	.41	
PRS Internalizing Composite		.08
PRS Externalizing Composite		.16
SR Internalizing Composite		-.96*
SR Hyperactivity/Inattention Composite		.93**
Total R^2	.47	
n	31	

Note. RSA scores were log transformed for Anger task.

$*p \leq 0.05$, $**p \leq 0.01$

Research Aim 3. The third aim of the research study was to investigate how emotion regulation strategies mediate the relationship between baseline RSA and RSA reactivity in children with varying levels of externalizing and internalizing behaviors. The first step was to determine if the BASC II Parent Report Externalizing, Parent Report Internalizing, Self Report Internalizing, and Hyperactivity/Inattention composites were significantly correlated with the Roberts-II Available Resources Scales, Problem Identification Scales, Resolution Scales, or the Outcome Scales. None of the hypothesized BASC II composite scales for the Parent Report or Self Report were significantly correlated with the Roberts-II proposed scales with the exception of one. The Parent Report Internalizing Composite scale was significantly positively correlated with the Problem Identification Description scale *r* (*n* = 30) = .42, *p* = .02. However, as none of the hypothesized subscales of the Roberts' II were significantly correlated with BASC II scales and RSA levels during experimental tasks, the meditational model could not be tested (see Table 8).

The following analyses were conducted to determine the relations between emotion regulation strategies and RSA levels during the experimental tasks. The bivariate correlations among RSA scores and Roberts-II scales are shown in Table 8. The Support Other Help and Reliance on Others scales were negatively correlated with RSA levels during the Attention task (*r* = -.374, *n* = 31, *p* = .042) and (*r* = -.37, *n* = 31, *p* = .042). The Resolution scale was positively correlated with RSA levels during the Natural Breathing Tasks (*r* = .41, *n* = 30, *p* = .02). There were no other significant correlations between RSA levels during any of the activities and the Roberts-II scales.

Table 8.

Summary of Correlations, Means, and Standard Deviations for scores on Roberts II Scales and RSA levels.

Roberts-II T-Scores	Paced Breathing n=31	Natural Breathing n=31	Attention Task n=31	Inhibition Task, n=30	Sad Film, n=31	Anger Film, n=30	*M*	*SD*
Popular Pull	-.16	.16	-.09	.08	-.18	-.09	51.36	7.15
Complete Meaning	. 31	.25	.19	-.19	.25	.13	41.16	8.37
Support Self-Feeling	.00	.02	.07	-.20	.11	-.16	54.36	11.74
Support Self-Advocacy	.08	.03	-.09	.04	.09	-.06	49.40	7.54
Support Other Feeling	-.19	-.01	-.26	-.18	-.12	-.16	43.56	6.72
Support Other Help	-.25	.00	-.37*	-.05	.16	-.27	41.60	5.91
Reliance on Others	.12	.29	-.37*	-.16	-.01	-.05	42.56	6.86
Limit Setting	.15	.27	-.10	-.09	.29	.00	51.20	9.70
PI-Recognition	-.11	-.03	.17	-.13	-.02	-.04	59.3	12.76
PI-Description	-.04	-.20	-.06	-.00	-.00	-.00	48.83	6.78
PI-Clarification	.18	.27	-.07	.13	.01	.05	43.70	9.98
Resolution 1	.03	.41*	-.03	-.23	.07	-.06	49.46	7.20
Resolution 2	.23	.23	-.01	-.14	.11	-.07	47.1	5.62
Resolution 3	.18	.16	-.28	-.03	-.00	-.04	46.83	4.80
Anxiety	-.02	-.13	.01	-.25	.07	.03	48.23	9.09
Aggression	.18	.17	.31	.12	.10	.15	45.33	7.33
Depression	.02	.15	.14	.32	.03	-.08	49.23	10.85
Rejection	-.12	-.22	-.13	-.07	.17	-.29	54.53	8.93
Unresolved	-.04	-.28	-.05	.17	-.23	.01	42.76	4.62
Non-adaptive	-.10	-.25	.08	.05	.07	.19	66.40	14.35
Maladaptive	.01	-.20	-.07	.06	.07	.08	64.90	12.55
Unrealistic	.13	.18	-.00	-.20	.15	-.15	61.06	12.7
Unusual/Antisocial	.15	.15	.26	.16	.08	-.11	72.80	9.42
Atypical	-.09	-.14	-.33	-.01	.05	-.06	63.50	17.03
M	9.11	7.90	.94	.92	7.18	.88		
SD	1.27	1.46	.11	.09	1.41	.07		

Note. RSA scores were log transformed for Attention, Inhibition and Anger task.

Sample sizes differ slightly based on missing items for RSA tasks.

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

Additional Analyses

Although natural breathing was selected as the measure of baseline, consistent with Aim #1 of the study, supplemental analyses of RSA levels during a paced breathing task as a controlling variable was examined in a series of four hierarchical multiple regression analysis to determine if the outcomes would be different in predicting RSA during attention, inhibition, sad, and angry conditions. The following variables were included in the respective models, RSA during a paced breathing task, Parent Report Internalizing Composite, Parent Report Externalizing Composite, Self-Report Internalizing Composite, and Self-Report Hyperactivity/Inattention Composite.

Paced breathing and RSA during attention task. In this model, RSA levels during an Attention task was an outcome in hierarchical multiple regression. Paced breathing RSA levels were entered in Step 1 and contributed 3% of the variance. When Parent Report Internalizing, Parent Report Externalizing, Self-Report Internalizing, and Self-Report Hyperactivity/Inattention was entered at Step 2, the total variance explained by the model was 26%, F (5, 25) = 1.78, p =.15), (see Table 9). Although the model was not significant, the Self Report Hyperactivity/Inattention Composite (β = -.74, b = -2.09, p = .04) predicted the majority of the variance in the model in that as the scores on the Hyperactivity/Inattention Composite increased, RSA levels during the attention task decreased. These results were similar to the results utilizing RSA levels during a natural breathing task as a control variable.

Table 9

Hierarchical Multiple Regression Analysis Predicting RSA Levels During an Attention Task Controlling for RSA Levels During a Paced Breathing Task

Predictor	RSA Attention	
	Δ R^2	ß
Step 1	.03	
Paced Breathing		
Step 2	.23	
PRS Internalizing Composite		.01
PRS Externalizing Composite		.19
SR Internalizing Composite		.23
SR Hyperactivity/Inattention Composite		-.74*
Total R^2	.26	
n	31	

Note. RSA scores were log transformed for Attention task
$*p \leq 0.05$, $**p \leq 0.01$

Paced breathing and RSA during inhibition task. For the second model, RSA levels during an Inhibition task was an outcome in hierarchical multiple regression. Paced breathing RSA levels were entered in Step 1 and contributed 0% of the variance. When Parent Report Internalizing, Parent Report Externalizing, Self-Report Internalizing, and Self Report Hyperactivity/Inattention composites were entered at Step 2, the total variance explained by the model was 28%, F (5, 24) = 1.90, p = .13 (see Table 10). In this model, RSA levels during a paced breathing task did not contribute to the overall variance. However, the Parent Report Internalizing Composite (β = -.45, b = -2.14, p = .04) contributed the unique variance to the overall model in that as the scores on the composite increased, RSA levels during the inhibition task decreased. None of the other variables added their own unique variation in predicting RSA levels during the inhibition task. These results were similar to the results utilizing RSA levels during a natural breathing task as a control variable.

Table 10

Hierarchical Multiple Regression Analysis Predicting RSA Levels During an Inhibition Task Controlling for RSA Levels During a Paced Breathing Task

Predictor	RSA Inhibition	
	Δ R^2	ß
Step 1	.00	
Paced Breathing		
Step 2	.28	
PRS Internalizing Composite		-.45*
PRS Externalizing Composite		.31
SR Internalizing Composite		.11
SR Hyperactivity/Inattention Composite		-.49
R^2	.28	
n	31	

Note. RSA scores were log transformed for Inhibition task
$*p \leq 0.05$, $**p \leq 0.01$

Paced breathing and RSA levels during a sad task. For the third model, RSA levels during a sad task was an outcome in hierarchical multiple regression. Paced breathing RSA levels were entered in Step 1 and contributed 15% of the variance. When Parent Report Internalizing, Parent Report Externalizing, Self-Report Internalizing, and Self-Report Hyperactivity/Inattention composite was entered at Step 2, the total variance explained by the model was 22%, F (5, 25) = 1.14, p = .25 (see Table 11). In this model, RSA levels during a paced breathing tasked contributed the majority of the overall variance (β = .39, b = 2.16, p = .04) whereas none of the other composites significantly contributed to the overall variance. These results were not similar to the results utilizing RSA levels during a natural breathing task as a control variable in that paced breathing significantly contributed to the overall variance in the model.

Table 11

Hierarchical Multiple Regression Analysis Predicting RSA Levels During an Sad Task Controlling for RSA Levels During a Paced Breathing Task

Predictor	RSA Sad	
	Δ R^2	ß
Step 1	.15	
Paced Breathing		
Step 2	.07	
PRS Internalizing Composite		-.13
PRS Externalizing Composite		-.15
SR Internalizing Composite		-.11
SR Hyperactivity/Inattention Composite		.37
R^2	.22	
N	31	

Note. **p* ≤ 0.05, ***p* ≤ 0.01

Paced breathing and RSA levels during an anger task. For the fourth model, RSA levels during an Anger task was an outcome in hierarchical multiple regression. Paced breathing RSA levels were entered in Step 1 and contributed 1% of the variance. When Parent Report Internalizing, Parent Report Externalizing, Self-Report Internalizing, and Self-Report Hyperactivity/Inattention was entered at Step 2, the total variance explained by the model was 34%, F (5, 24) = 2.49, p = .05 (see Table 12). In this model, RSA levels during a paced breathing task did not contribute to the overall variation (β = .07, b = .43, p = .66). The SR Internalizing Composite (β = -.73, b = -2.32, p = .02) and the Self Report Hyperactivity/Inattention (β = .73, b = 2.13, p = .04) each contributed significantly to the overall model, whereas the other BASC scores did not significantly contribute to the overall model. These results were similar to the results utilizing RSA levels during a natural breathing task as a control variable.

Table 12

Hierarchical Multiple Regression Analysis Predicting RSA levels during an Anger task Controlling for RSA Levels During a Paced Breathing Task

Predictor	RSA Anger	
	ΔR^2	ß
Step 1	.01	
Paced Breathing		
Step 2	.32	
PRS Internalizing Composite		.07
PRS Externalizing Composite		.17
SR Internalizing Composite		-.73*
SR Hyperactivity/Inattention Composite		.73*
R^2	.34	
n	30	

Note. RSA scores were log transformed for Anger task

$*p \leq 0.05$, $**p \leq 0.01$

Repeated Measures Analysis of Variance across RSA Tasks. To understand the nature of change in RSA levels across paced breathing, natural breathing, attention, inhibition, sad, and anger tasks, a repeated measures ANOVA was used. The repeated measures ANOVA with a Greenhouse-Geisser correction due to violation of sphericity determined that there was a statistically significant difference between RSA levels during different tasks, F (1,28) =7.22, p =.001. Post hoc tests using the Bonferroni correction showed that RSA levels during a natural breathing task (M =7.86, SD = .27) was statistically different than RSA levels during paced breathing task (M =9.13, SD =.24, p =.001). Additionally, RSA levels during a paced breathing task (M =9.13, SD =.24, p=.001) was significantly higher than RSA levels during an anger task

(*M* =7.63, *SD* =.26, *p* =.003). Post hoc tests using the Bonferroni correction also revealed that RSA levels during a sad task (*M* = 7.17, *SD* = .24, *p* =.001) was statistically lower than RSA levels during an attention task (*M* =8.92, *SD* = .46, *p* =.024). Thus, individuals were physiologically more in sync during a paced breathing task relative to natural breathing, during a paced breathing relative to an anger condition, and an attention task relative to a sad task.

Table 13

RSA Levels across Paced breathing, Natural Breathing, Attention, Inhibition, Sad, and Anger Tasks

Task		**RSA Levels**	
	n	**M**	**SD**
Paced Breathing	29	9.13	.24
Natural Breathing	29	7.86	.27
Attention	29	8.92	.46
Inhibition	29	8.41	.30
Sad	29	7.17	.24
Anger	29	7.63	.26

CHAPTER FIVE: DISCUSSION

The purpose of the present study was to investigate how RSA is affected across paced and natural breathing, attention, inhibition, and emotion-eliciting tasks and how those relationships may be mediated by emotional regulation strategies in children with different levels of externalizing and internalizing behaviors between the ages of 8 and 12 years of age. Research has shown that externalizing and internalizing symptoms have negative effects on peer relationships, psychopathology, and academic difficulties (Feng, et al., 2008; Beauchaine, Gatzke-Kopp, & Mead, 2007; Bub, McCartney, & Willet, 2007; Denham, Blair, Schmidt, & DeMulder, 2002). Research understanding the physiological processes associated with emotion regulation may provide further information regarding emotion reactivity to situations that evoke emotional responses. There were several aims included in this study in order to determine how individuals' respiratory sinus arrhythmia is a function of their internalizing and externalizing behaviors. Methodological issues including a debate as to whether the indicator for baseline RSA should be paced or natural breathing and understanding the effects of cognitions such as attention and inhibition on RSA levels confounded interpretation of previous research. This study attempted to understand these affects by providing a series of tasks that compared natural and paced breathing methods and how internalizing and externalizing behaviors may predict individual's RSA reactivity in specific tasks. Lastly, this study also examined how emotion regulation strategies may be a mediator in the relationships between RSA levels and internalizing and externalizing symptoms.

Baseline RSA: Natural or Paced Breathing

The first aim was to determine whether internalizing and externalizing behaviors were more predictive of RSA levels during a paced breathing task or a natural breathing task. The hypothesis was that externalizing and internalizing behaviors would be more predictive of RSA during a paced breathing task rather than a natural breathing task. As Porges (2007) stated, a natural breathing task should be utilized as this is a true measure of an individual's resting RSA. However, Grossman and Taylor (2007) argued that there are individual differences in breathing rates that impact RSA levels that may confound results. Contrary to the hypothesis, the results showed that internalizing and externalizing behaviors did not predict baseline RSA levels during either a paced or natural breathing task in this small sample of 31 participants. In other words, baseline levels of RSA during a paced breathing task or a natural breathing appear to not decrease or increase based on internalizing or externalizing symptoms. This finding is different than previous findings that indicated that baseline levels of RSA decrease as levels of externalizing (Beauchaine et al., 2006; Dietrich et al., 2007; Hastings et al., 2008; Hinnant & Sheikh 2009) or internalizing symptoms increase (Forbes et al., 2006; Greaves-Lord et al., 2007; Hinnant & El-Sheikh, 2009). However, of the these studies that examined baseline RSA levels and externalizing and internalizing symptoms, two examined preschool aged children (Forbes et al., 2004; Hastings et al., 2007) and two studies focused on 10-13 years of age (Dietrich et al., 2007; Greaves-Lord et al., 2007). Two of the studies included the age range of this sample population but one was focused on children with oppositional defiant and conduct disorders (Beauchaine et al., 2006) and Hinnant and El-Sheikh (2009) examined the interaction of baseline RSA and RSA reactivity in predicting externalizing and internalizing symptoms. While age did not correlate with baseline RSA levels within this sample, the small sample size may have impacted the ability to find an effect of age.

As noted, the participants within the Beauchaine's et al. study were children with high levels of externalizing behaviors, which may indicate that children with clinical levels of externalizing behaviors may exhibit baseline RSA level differences in comparison to healthy controls. The current study may not have had the extreme levels of externalizing or internalizing symptoms necessary to detect baseline differences. A conclusion derived is that in relatively healthy controls, baseline differences in RSA do not appear to be a function of externalizing or internalizing behaviors in either a paced or natural breathing task. The fact that Calkins et al. did not find significant baseline RSA levels and the present study of comparatively healthy 8-12 year olds may be further evidence that baseline difference may not occur until after early childhood and only for those with high levels of externalizing or internalizing behaviors as Beauchaine et al. hypothesized. A longitudinal study that examines age-related changes in RSA in relation to externalizing and internalizing symptoms from early childhood through adolescence may be an important future direction.

Additional analyses did provide information about whether paced or natural breathing can be used interchangeably. The models substituting paced for natural breathing were comparable to the ones, which included natural breathing in the model. In other words, Paced Breathing contributed a unique variance in explaining the overall model However, a repeated measure ANOVA showed that there was a significant difference between natural and paced breathing RSA levels. Thus, researchers need to be cognizant of what RSA levels they use for baseline levels especially in terms of analyzing tasks that target negative emotions particularly sad emotions.

Internalizing and Externalizing Behaviors Across Tasks

The second research aim was to determine how RSA levels during an Attention, Inhibition, a Sad emotion eliciting and Anger emotion eliciting tasks were predicted by internalizing and externalizing behaviors. The first hypothesis was that as internalizing symptoms increase there would be more change in RSA levels, or in other words, internalizing symptoms would account for more variance in RSA levels across an Attention, Inhibition, Sad emotion eliciting, and an Anger emotion eliciting tasks.

Anger task. RSA levels during an anger emotion-eliciting task were also examined in relation to RSA levels during a natural breathing task. The hypothesis was that as externalizing levels increase, there would be less RSA reactivity and as internalizing levels increase there would be greater RSA reactivity. This model was significant with a p-value of .006 in accounting for 47% of the variance in RSA reactivity, which is a moderate to large effect. . At the time of this study, one previous research study found that adolescents with conduct disorder and healthy controls showed lower RSA levels during an anger-eliciting task relative to baseline RSA levels which is supported by this study's results. Other studies have examined a stress response (El-Sheikh, 2001; Greaves-Lord et al., 2007; Willemen et al., 2008) but have not targeted specifically an anger emotion. This study is unique in that RSA levels during a task that targeted the emotion anger has rarely been examined in children between the ages of 8 to 12 years of age.

In terms of understanding the relations between the internalizing and externalizing symptoms, as internalizing symptoms increased, RSA levels during the anger task decreased. The opposite relationship was true for externalizing symptoms in that as self-report inattention and hyperactivity levels increased, RSA levels during the anger task also increased. This finding points to the possibility that they may be a fundamental difference in how children with higher levels of externalizing behaviors versus children with higher levels of internalizing behaviors respond to various emotions. If replicated in a larger study, it may be the case that the higher levels of RSA during an anger task for children with higher levels of externalizing symptoms means that they are regulating their response to the said emotion and vice versa for children with internalizing symptoms in that they are less able to regulate their response to an anger task. However, this may be a faulty conclusion as Gentzler et al.'s (2009) study suggested that healthy controls respond flexibly in emotion eliciting tasks. In other words, in healthy controls, decreases in RSA relative to baseline RSA are expected and points towards healthy emotion regulation. Therefore, future research would need to include healthy controls, in addition to individuals with high levels of externalizing symptoms only, and high levels of internalizing symptoms only to determine if this study was a result of a comparatively healthy population.

Attention Task. Based on the results of this study, internalizing symptoms were not significant in predicting RSA levels during an attention task when controlling for baseline RSA levels during a natural breathing task. While the overall model was not significant in predicting RSA levels during an attention task, there was a moderate effect size meaning greater than .25 (Ferguson, 2009), in accounting for the variance in RSA levels in an attention task. As an individual variable, children with higher levels of self reported hyperactivity and inattention are more likely to have less regulated RSA during activities that require attention.

Previous attempts to *predict* RSA levels during an attentional task have not been found in the literature. Although previous researchers have found that individuals' RSA levels significantly lowered during a sustained attention task in adults relative to baseline RSA levels (Duschek et al., 2009), the current study is unique in attempting to understand RSA during attention tasks as a function of behaviors. While the current study did not find significant differences in RSA levels during an attention task from baseline levels of RSA in either a paced breathing or natural breathing task, this may be due to age differences. Overall, internalizing symptoms appear to not predict RSA levels during an attentional task based on the results of this study.

In terms of externalizing behaviors predicting RSA levels in an attention task was also not significant, but there was a trend for individuals self report measures of inattention and hyperactivity levels to predict decreases in RSA levels relative to baseline RSA levels during a natural breathing task. In other words, self-report levels of inattention and hyperactivity accounted for the majority of the 27% of the variance the model predicted. Again, predicting RSA levels during an attention task using parent and self-report measures has not been attempted in prior research, at least to the knowledge of the author of this present study.

Inhibition Task. The model that examined RSA levels during an Inhibition task being predicted by internalizing and externalizing behaviors while controlling for RSA levels during natural breathing tasks approached significance at the p = .08 level. In terms of externalizing behaviors, there were no significant findings. In this particular model in relation to an inhibition task, externalizing symptoms explained very little of the overall variance in RSA reactivity. In contrast, internalizing symptoms did significantly account for t*he variance in R*SA levels during an inhibition task. In other words as internalizing levels increased, RSA levels during the inhibition task decreased after controlling for RSA levels during a natural breathing task. Overall, internalizing symptoms had unique variance in contributing to the overall model. Thus, leading to the conclusion that as children's level of internalizing symptoms increase, RSA levels decrease in inhibition task. Children with relatively higher levels of internalizing symptoms are less regulated during task of inhibition. This is an conceptually an intriguing finding as children with internalizing symptoms and children with externalizing symptoms may physiologically respond differently to specific tasks. Perhaps children who are considered internalizers show their dysregulation in tasks that require them to inhibit a response and children that are considered externalizing (specifically on inattention/hyperactivity scales) show their dysregulation in tasks that require them to perform in a noted area of weakness, attention task. However, these results need to be interpreted with caution due to the small sample size with scores in the relatively normal range of internalizing and externalizing symptoms. Future research should consider examining clinical subgroups such as those with clinical levels of internalizing or externalizing behaviors as well as those with ADHD.

Prior research has been very limited in terms of predicting RSA levels during an inhibition task in that no prior research studies have been found. However, some researchers have examined RSA baseline or reactivity and performance on an inhibition measure (Mezzacappa et al. 1998). Mezzacappa et al. found that RSA baseline levels were significantly positively correlated with their performance on the task, which was not found in this study. Munoz, & Anastassiou-Hadjicharalambous (2011) did not find any differences between RSA reactivity and children's levels of performance on an inhibition task in preschool aged children. This study also did not find any correlation between performance on an inhibition task and RSA baseline or RSA reactivity during an inhibition task.

Sad Task. Supporting previous findings by Beauchaine et al., (2005), this study found that higher levels of hyperactivity and inattention were more predictive of variance in RSA levels in response to a sad film clip. Both this study and Beauchaine's et al., study (2005) used the same film clip, a three-minute segment from the movie "The Champ." The overall model was not significant in predicting RSA levels during a sad task from internalizing or externalizing behaviors though there was a moderate effect size of the overall variance being explained by the model. Upon examining the contributors to the overall model, there was a trend for these 8 to 12 year-olds who had higher levels of self-reported hyperactivity and inattentive behaviors to have a larger RSA reactivity in a sad task relative to RSA levels in a natural breathing task than internalizing behaviors.

Internalizing symptoms did not contribute to the overall model in that there was no relationship to RSA levels during a sad task. Gentzler et al. (2009) found that greater decreases in RSA in response to the same sad film clip was a predictor of less depressive symptoms concluding that RSA reactivity was a healthy response to an emotion-eliciting task. Children with smaller RSA reactivity were more likely to have higher levels of depressive symptoms (Gentzler et al., 2009). In this particular study, depressive and anxious symptoms were examined together in one overall internalizing composite and therefore may not have had the sensitivity to parse out differences between individuals with anxiety versus depressive symptoms. Overall, in terms of RSA levels during a sad emotion-eliciting task relative to baseline RSA levels during a natural breathing task, hyperactivity and inattention symptoms were more predictive than internalizing symptoms, which is contrary to the hypothesis that externalizing would have less change than internalizing symptoms.

Based on the results of the primary analysis, a series of additional analysis were conducted in order to fully understand the results of the present study. As no significant correlations were found in this sample RSA levels and RSA levels during natural or paced breathing tasks, additional hierarchical multiple regression analysis were conducted using RSA during paced breathing as a control rather RSA during natural breathing to determine if there differences in the results. The results of the paced breathing as a control variable were similar in all of the models on all of the tasks except for the sad task. RSA during paced breathing significantly accounted for the variance in RSA level during a sad task with a *p* value of .004. In other words, based on the results of this study, forcing synchronicity during a paced breathing task resulted in similar RSA levels to RSA levels during a sad task.

Conceptually, the significant difference between RSA during paced breathing and RSA during a sad emotion-eliciting task may indicate that individuals are responding physiologically to the sad film in comparison to a baseline paced breathing task. In other words, a natural breathing control variable may mask findings relative to tasks aimed at eliciting sadness. However, in terms of the other tasks, attention, inhibition, and anger, the differences between the two different control variables are negligible. The hypothesis in this study was that externalizing and internalizing symptoms would better predict RSA levels during a paced breathing task and that paced breathing needs to be a control variable. This hypothesis was not supported in that overall there were minimal differences between the two control variables. However, controlling for natural or paced breathing RSA levels may be necessary in terms of understanding RSA when examining the emotion of sadness.

The third aim of the study, which is to investigate how emotion regulation strategies may mediate the relationship between baseline RSA and RSA reactivity in children with varying levels of externalizing and internalizing behaviors could not be investigated, as there were no significant correlations between the hypothesized variables. However, the reason this aim was put forth was that research has shown that individuals with internalizing and externalizing symptoms display different ER strategies (Liverant et al., 2008; Calkins et al., 1999; Garnefski, et al. 2005; Moore et al., 2008; Supplee, 2009; Shipman, 2003; Tull, 2007; Suveg, 2008; Maughan & Cicchetti, 2002). The application of these varying strategies have implications for how children manage their emotions to different events. Understanding the physiological underpinnings of emotion regulation in youth with internalizing and externalizing symptoms may have provided information to guide future research on what aspects of behaviors and physiological processes need to be modified in order to promote adaptive functioning (Beauchaine et al., 2007).

There are several limitations encountered in this study. One limitation to this study is the small sample size as several of the models had a high level of variation accounted for but was not significant, which may have been due to the lack of power. Additionally, there is a lack of generalizability to real world situation given that the tasks were conducted in a laboratory setting and selected based on tasks used in RSA literature. The measurements used such as the BASC-II and Roberts-2 may have also limited the findings as the norming population may have differed than the study's population. For example, there was a higher number of Mexican-American's in this study while the norming population in the Roberts-2 was primarily Caucasian. Another limitation is that this study did not ask the participants' subjective responses to the emotion eliciting tasks. Prior research as shown that the specific film clips selected to elicit feelings of sadness and anger were successful in eliciting said emotion, this study cannot determine discern if the actual feeling targeted was elicited.

However, a strength of this study was that the sample included a high number of minorities in that 51% of the sample population was Hispanic. To the author's knowledge there have not been studies that examined race or ethnicity differences in RSA in children and the majority of the experimental research with RSA have participants who were primarily Caucasian. Future research should be focused on understanding how children with predominately internalizing symptoms and children with predominantly externalizing may differ in terms of their physiological response to various emotion eliciting tasks. While this study primarily focused on understanding how parent or self-report of symptoms may predict RSA reactivity across tasks, future research may want to focus on how this is translated into the school setting by including teacher report of behaviors, grades, and academic achievement. As prior research has shown a connection between emotion regulation and positive school outcomes (Schelble et al. 2010), understanding biological variables that impact emotion regulation may be crucial in determining at-risk populations as well as targeting potential interventions to help foster healthy emotion regulation.

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