EMOTIONAL AND PHYSIOLOGICAL REGULATION DURING PARENT-CHILD INTERACTION IN PRESCHOOLERS

by

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ABSTRACT

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The purpose of the current study is to examine physiological and behavioral components of emotional regulation and the development of empathy in preschoolers. It also examines how the parents play a role in their child's development of emotional competence. Behavioral and physiological responses were assessed for the children during stories chosen for emotional content (one happy and one sad story for each parent). Maternal and paternal ratings of self-expressivity were collected using the Self-Expressiveness in Family Questionnaire (Halberstadt et al., 1995). Greater vagal suppression occurred during the sad conditions suggesting that negative emotions require more processing strategies. Greater attentional scores were related to the child's RSA and higher resting RSA was associated with great motor restriction. The mothers had higher SEFQ scores than the fathers. Higher maternal positive expressivity, lower maternal total

expressivity, and lower paternal positive expressivity scores were related to the children's displays of empathy.

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LIST OF TABLES

LIST OF FIGURES

I. INTRODUCTION

The early childhood years have been identified as a crucial period for the maturation of the necessary mechanisms required for social competence and appropriate social behavior later on in life. Calkins and colleagues (1999) believe that a critical component of social interaction is the development of affective processes and emotional understanding. Emotions have become a popular area of study because they are important regulators and organizers of everyday experience (Lagattuta & Wellman, 2002). They influence how we perceive and respond to people and dictate whether interpersonal bonds and relationships are formed. Self-regulation of affect allows children to gain the skills required to comprehend and explain emotional experiences and inhibit inappropriate impulsive responses.

Emotional self-regulation is an essential component of self-management for preschoolers as they acquire a greater variety of self-initiated strategies of emotional control. Two dimensions of emotional functioning that play a role in successful social interactions are emotional reactivity and emotional regulation (Eisenberg, Cumberland, & Spinrad, 1998). Emotional reactivity is the level of intensity and duration of affective arousal an individual can handle. Emotional regulation is defined as a person's ability to employ healthy strategies to understand and manage emotional experiences. These two components are not independent of each other. Both play a part in how a person responds to an emotional cue and whether a person can acquire proper social behavior. Emotional control is influenced by both extrinsic and intrinsic processes. Extrinsic sources such as parents and peers create the environment for learning and developing socio-emotional skills. Intrinsic processes dictate how that individual reacts to the external environment cues, and these are modulated by temperament and cognitive skills. Fabes, Holmgren, and Eisenberg (1998) found that individuals who are highly emotional in response to anger-inducing events and poor at regulation are likely to display aggression in social settings. These findings demonstrate the importance of emotional self-regulation and how discrepancies between emotional regulation and reactivity can lead to conflict behavior or even the development of psychopathology. Understanding mechanisms of emotional self-regulation is important for identifying developmental problems and for helping preschoolers learn strategies to self-regulate during the socialization process.

The present study examines the physiological and behavioral components of emotional regulation and the development of empathy in preschoolers. This study also focuses on the parent-child relationship during the socialization of emotions and investigates how the parents play a role in their child's development of social and emotional competence. Physiological components were studied by looking at the variability in preschoolers' cardiac vagal tone to see how children respond and regulate during emotion-provoking stimuli. A happy story and a sad story were chosen to assess whether individual differences in processes effect how pleasant and unpleasant emotions are modulated during emotionally-evocative situations.

A majority of parent-child interaction studies are done with infants because babies almost exclusively rely on caregivers to be regulators of emotion. However, the current study chose preschoolers because this is a time in development when the child is starting to learn how to regulate on his or her own. This specific age group needs further investigation because it is an age where children use a combination of internal and external cues to help shape their emotional maturity. They cannot completely regulate, but they are starting to break away from their reliance on their caregivers. The study expands on how parental influences affect child socio-emotional development by including both mothers and fathers. Each parent has a different socialization influence on the child as he or she develops empathy. It is important to not only focus on the primary caregiver, but to look at how each component of the family dynamic plays a part in the shaping the offspring's emotional and social skills.

Empathic Behavior

The ability to manage emotion plays an important role in vicarious emotional responding. In the past few decades there have been numerous studies (Calkins, Dedmon, Gill, Lomax, & Johnson, 2002; Kochanska, Friesenborg, Lange, & Martel, 2004) that have demonstrated that babies are equipped with emotional capacities to experience the environment around them from birth. Human infants are endowed with the neural processes necessary for the perception and expression of emotions required for forming the social interactions essential for infant's survival (Diego & Jones, 2007; Jones, 2012). Simner (1971) has shown that newborns as young as 36 hours of life react to the distress of another infant. Hoffman (1975) suggested that this reflexive crying may signify an instinctive precursor to empathic distress. Empathic behavior develops across infancy as socio-emotional capacities form from the basic affect-processing mechanisms. As the individual continues to grow, cognition and language develop, which allow for the child to effectively learn how to communicate current emotional states. Although researchers disagree on the precise time when empathic behavior and responses fully emerge, children tend to start demonstrating prosocial behavior between the ages of two and three years old (Eisenberg, 2006). During this time in development, preschoolers acquire the skills to express emotions effectively and experience another person’s point of view.

The maturation of empathy occurs after there is an integration of emotional and cognitive processes that produce a comprehension of prosocial behavior (Hinnant & O’Brien, 2007). Empathy and prosocial behavior are positively associated with the state of sympathy. Eisenberg (2006) defines empathy as an emotional reaction that is based on the comprehension of another’s emotional state and is similar to what the other person is feeling or would expect to feel in that given situation. Sympathy is defined as an other-oriented emotional reaction to another’s emotional state or condition (Fabes et al., 1994). Both sympathy and empathy are used to help regulate social behavior and to garner emotional control. Sympathy is different than empathy in that the emotion experienced is not similar to the other’s emotional state, but rather it is feelings of concern or sorrow towards that other person. Personal distress is a self-oriented aversive reaction to another’s situation (Batson, 1991). Individuals who are unable to manage their emotional reactions are more prone to experiencing personal distress. It is an empathic behavior that usually occurs during the first year of life as the baby learns how to respond to emotional episodes. However, it is believed that by the time an individual reaches preschool, that child should have the emotional maturity to understand prosocial behavior. By this time in development, personal distress should be managed appropriately as a person gains the ability to regulate emotional stimuli effectively by concentrating on other-oriented focus rather than just self-oriented focus.

Temperament Effects

Temperament links individual differences in behavior to underlying neural networks and is measured by the latency, intensity, and recovery of response that modulate reactivity (Rothbart, 2007). There is considerable variability among children because temperamental differences are biologically based. Although every person is born with a specific temperamental repertoire, the expression of temperamental reactivity is expected to change as a person gains new understandings about the environment around him or her. Temperamental reactivity is the responses to change in the external and internal environment, measured in terms of the intensity of emotional orienting and motor reactions (Rothbart, Rueda, Sheese, & Posner, 2011). Attention processes help to support temperamental effortful control and modulate self-regulation. The majority of recent research on the dimensions and characteristics of early temperament are focused on patterns of negative affect and how the child reacts to distress-provoking stimuli (Calkins, Dedmon, Gill, Lomax, & Johnson, 2002).

Rothbart and colleagues (2011) found that at 13 months of age, babies' disengagement of attention was related to lower levels of negative emotion. Infants can regulate emotional and physical reactions through attentional control by redirecting their focus during overstimulation. Buss and Goldsmith (1998) found that a number of different behaviors that infants displayed when observing frustrating situations appears to reduce their negative affect. Each person reacts differently depending on that individual's temperamental threshold. It is important to study associated behaviors that may be correlated with or a consequence of a temperamental characteristic. It has been hypothesized that the differences in reaction to novelty between temperamentally inhibited and uninhibited children arises from inherited variation in the excitability of the neural circuits in the limbic system (Kagan & Snidman, 1991). Diamond (2001) found that during the second half of the first year of life, there is good evidence for the development of inhibitory motor control in babies. Although the behavior is rudimentary during this time, inhibition of inappropriate motor activity, self-comforting activities, and help-seeking strategies continue to improve during early childhood maturation.

Effortful control is considerably developed by the preschool years and extends into adulthood (Posner & Rothbart, 2007). It is defined as the ability to inhibit a dominant response in order to perform a subdominant response, detect errors, and engage in planning (Rothbart & Rueda, 2005). High effortful control is consistently related to low negative emotions (Rothbart, Rueda, Sheese, & Posner, 2011). High levels of effortful control are also related to approach-oriented coping strategies to distract and plan during stressful situations. Effortful control is positively correlated with empathic behavior. It provides attentional flexibility needed to react to negative feelings in others without being overwhelmed by them (Rothbart, 2007). However, low effortful control is a strong predictor of behavior problems, especially externalizing problems. Children with high levels of negative emotionality need to learn how to problem solve during uncomfortable conditions to limit problematic reactions and behaviors.

Resolving emotional conflict greatly increases during the preschool years (Rueda, Posner, & Rothbart, 2005). This practice with emotionality helps children learn to regulate temperament reactivity and limit greater levels of negative emotionality. There are rapid improvements in inhibiting impulsive behaviors during early childhood as well. Preschoolers learn reactive control in order to manage automatic or involuntary responses. The ability to self-regulate is critical during the preschool years as children begin to gain independence and learn to cope with developmental challenges.

Familial Influences

Parents create the socializing environments based on the child's needs, and both the parents and the child play a role in social and emotional regulation. A child's development of social competence is influenced by the manner in which parents respond to the temperament of the child. Parental behaviors during emotional situations with their child are based not only on the parent's socialization techniques and beliefs, but also on the mothers' and fathers' perception of the child's capacity for managing emotions. Both intrinsic and extrinsic factors play an equally important role in whether a child develops self-regulation of emotion. Extrinsic aspects involve the socialization processes where a child learns self-control and how to display socially-appropriate expressions of emotion (Fox & Calkins, 2003). Parent-led conversations about the causes and consequences of different emotions may assist in children learning appropriate reactions during emotional experiences. Children with lower physiological regulation may depend more on external socializing agents to obtain necessary socio-emotional skills.

Parental flexibility, awareness, and responsivity promote self-regulating behaviors. Parents' pattern of child management is very important to how a child transitions to early childhood. Extensive parental support is likely critical in early childhood during the child's transition to greater autonomy (Fox & Calkins, 2003). There has been a growing consensus that positive parent-child interactions are important for competent socio-emotional behavior. Sensitive and responsive mothers may help children who have regulatory difficulties develop appropriate social behavior (Degnan, Calkins, Keane, & Hill-Soderlund, 2008). However, intrusive or hostile mothers may intensify the child's poor reactivity and cause more harm later in life. Maternal negative and controlling behavior is negatively related to the offspring's ability to control attention and engage in distraction techniques (Fox & Calkins, 2003). Maternal behavior can either enhance or undermine the development of the child's important regulatory skills. Although little is known about fathers' emotion socialization, McElwain, Halberstadt, & Volling (2007) suggest that paternal influence plays a unique, but equally important role in the child's emotional and social development.

Eisenberg, Cumberland, and Spinrad (1998) hypothesized that a youth's willingness to express and experience emotions is related to parents' expressivity. Parental expressivity is defined as the dominant style of exhibiting nonverbal and verbal expressions within a family (Halberstadt et al., 1995). Expressivity is usually measured through self-reports and is made up of three categories. Positive expressiveness refers to positive emotional expressions such as praising someone, demonstrating admiration, and/or expressing gratitude for a favor (Valiente, Eisenberg, Fabes, Shepard, Cumberland, & Losoya, 2004). Negative dominant expressiveness is defined as displays of emotions that are assertive and ominous. Expressions of anger and hostility typically fall under this group. The last category is negative submissive expressivity which involves fewer assertive negative displays such as sulking, sorrow, and crying. Parents' positive expressivity is positively related to children's social competence, whereas parents' negative dominant expressivity is inversely correlated to children's social adjustment. Valiente and colleagues (2004) found that parental negative dominant expressivity is more likely than parental negative submissive expressivity to have a negative effect on the socio-emotional development of a child because there is a greater risk of over-arousal in children which could result in personal distress.

Children learn about and experience others' emotions through exposure to parental expressivity. Mothers who score high in positive emotional communication report high level of prosocial behavior and have children who have low ratings of distress. Children are more likely to foster an understanding of an experience of emotions if they are exposed to high levels of positive emotions. Empathy and sympathy have been associated with parental involvement and satisfaction with the parenting role (Koestner, Franz, Weinberger, 1990). Children exposed to high levels of negative affectivity in the home may, over time, feel increasingly distressed by such emotion and increasingly likely to respond to others' negative emotions poorly (Valiente et al., 2004). It is important to stress that some degree of negative emotion is healthy for the promotion of sympathy, but only if a child is given the opportunity to learn about the different emotions and the appropriate responses to these emotions.

The majority of past emotion research has focused on the mother-child relationship, whereas the fathers' responses to an offspring's emotions have seldom been examined. However, Cassano, Perry-Parrish, and Zeman (2007) concluded that fathers generally display less supportive and more nonsupportive responses to children's negative emotions. Children whose fathers responded with negative emotions to their children's displays of negative emotion were less socially skilled (Carson & Parke, 1996). This suggests that the father-child relationship plays a substantial role in the socialization process. In one study of 4 and 5 year olds, fathers who reacted to their children's displays of negative emotion during physical play with negative emotions had children who were more aggressive and avoided others at preschool (Eisenberg, Cumberland, & Spinrad, 1998). These findings suggest that the quality of both parents' reactions to children's negative affect influences the children's emotional security during social interactions.

Kochanska and colleagues (2004) focused on how parents' personality influences their emerging relationship with their infant and how each individual in the family triad plays an active role in establishing that relationship. Their results suggested that there are potentially different determinants of parenting behavior in men and women. Although there are differences in personality and approaches to parenting, both the mothers' and the fathers' behaviors were significantly correlated to the infants' assessed temperament and the quality of the parent-child relationship. More research is needed to establish how these differences in parenting behavior affects development beyond infancy and how each participant in the triad plays a role in the formation of the parent-child affective relationship, which lays the foundation for the socialization process later on in life.

Physiological Measure of Vagal Tone and Heart Period Variability

To get a better understanding of the physiological processes that are instrumental during emotional regulation, one must first understand how the systems of the body produce cardiac activity. The autonomic nervous system (ANS) is made up of afferent and efferent feedback pathways that integrate neurophysiological processes such as linking the central nervous system to cardiac activity. Porges (1991, 1996) proposed a hierarchical model of self-regulation that assumes that complex behavioral regulation is dependent on proper physiological regulation, as measured by heart period variability (variability around average heart period). He created a theory demonstrating that variation in cardiac rate reflects the integrated system of control that alters cardiac rate in response to stress. The polyvagal theory uses two subsystems of the autonomic nervous system (ANS), the sympathetic nervous system (SNS) and the parasympathetic nervous system (PNS), which work together to maintain the body's homeostasis. The SNS increases in activity to promote metabolic output to handle environmental changes and to accelerate heartbeats. The PNS is responsible for the decreases in heart rate to conserve energy for the vital organs in the body. The PNS system increases during expiration and decreases during inspiration. This rhythmic pattern is called the respiratory sinus arrhythmia (RSA). RSA measures the variation in interbeat intervals (IBI) of the heart at the frequency of breathing and is interconnected with the vagus nerve. The myelinated vagus nerve sends input to the heart and causes changes in cardiac activity which allows the body to adapt to environmental changes. Parasympathetic pathways play a key role in the regulation of state, motor activity, and emotion (Porges, 2003). The variability in heart period that occurs in line with inspiration and expiration can be measured by a method which tracks the amplitude and period of oscillations associated with each phase of respiration (Porges, 1985, 1991, 1996). Heart period (HP) is measured by the lengths of the interbeat intervals and the heart period variability (HPV) is derived from the standard deviation of the IBIs. Vagal tone is the reflection of the PNS influence on heart period variability and measures the RSA. Even though RSA is not the same as cardiac vagal tone, RSA often is used as an indicator of cardiac vagal tone because vagal tone is influenced by RSA (Grossman &Taylor, 2007). Baseline vagal tone can be used as a contributing variable to individual differences in modulation and may predict temperamental regulation and arousal levels. Vagal withdrawal or suppression during demanding tasks may reflect the transition from internal homeostasis regulation to the generation of coping mechanisms for controlling behavioral arousal. Past research has indicated that vagal suppression during challenging situations is related to better state regulation and more attentional control (Calkins & Fox, 2002). Vagal withdrawal occurs when there is a change in RSA from baseline to a task measure. It is directed by decreases in RSA during evocative situations that require coping strategies and emotional control.

Feedback processes of the PNS can be either adaptive or maladaptive, depending on when in the emotional experience the physiological response is elicited. High resting vagal tone is associated with appropriate emotional responses, whereas low heart rate is a core characteristic of aggressive behavior in adolescents and adults (Lahey, Hart, Pliszka, Applegate, & McBurnett, 1993). Several studies have linked high baseline RSA in newborns with favorable developmental outcomes, suggesting that there is an important physiological component of appropriate engagement with the environment (Calkins & Fox, 2002). Greater RSA prior to stress stimulus reveals an enhanced capacity for self-regulation and socialization.

RSA and vagal measures are identified as suitable for the study of physiological links to multiple dimensions of behavioral functioning in young children (Huffman et al., 1998). Calkins and Dedmon (2000) reported that reductions in RSA characterized preschool children's response to tasks that required regulation of both negative and positive affect. Considerable research suggests that vagal withdrawal is linked to a range of regulatory behavioral processes and can be detected early in development (Thompson, Lewis, & Calkins, 2008). Attention-demanding tasks are correlated with decreases in heart period variability initially as attention is directed outward. Sustaining attention and responding to stress typically elicit a decrease in RSA (Eisenberg & Sulik, 2012). In 1985, Richards reported that infants who sustain attention to a stimulus show greater RSA suppression. Children with greater vagal suppression to cognitively and emotionally challenging tasks have higher status with peers and lower levels of externalizing problems (Graziano, Reavis, Keane, & Calkins, 2007). These physiological measures are also related to transitions through maturation. Calkins and Keane (2004) believe that the magnitude of the RSA suppression should increase from infancy to preschool-age, as the child develops a regulatory repertoire. The preschool population was chosen to further investigate whether increases in RSA suppression lead to displays of control over attentional and behavioral skills. Physiological processes were analyzed in conjunction with the preschoolers' temperamental behaviors and the parents' expressivity ratings to see how intrinsic and extrinsic cues influence children as they develop emotional control and emotional socialization strategies.

II. HYPOTHESES FOR PROPOSED STUDY

Heart Period Variability during Two Conditions Hypotheses

Hypothesis 1. Tonic vagal influence can be measured by looking at the heart period variability that is bound to the respiratory cycle. Since the happy story and the sad story conditions focus on two different emotions, it is hypothesized that (a) the child’s heart period variability will differ between the happy story and the sad story.

Both stories provoke different reactions, so differences in vagal activity are expected. If differences are found, it is predicted that (b) the child’s heart period variability will be lower during the sad story than the happy story because negative emotions are more developmentally complex and require more complicated processing strategies. Heart period is a more reliable depiction of the ANS influences than heart rate because it is considered a measurement of “cardiac time” rather than “real time” (Graham, 1978). Heart period is measured by the length of the interbeat intervals (IBI). Shortened IBIs signify an increase in heart period brought on by vagal suppression (Berntson, Cacioppo, & Quigley, 1993). With that said, (c) the child’s heart period will be higher during the sad story than during the baseline because the task demands will suppress vagal tone during the story.

Vagal Influence on Behavioral Processes Hypotheses

Hypothesis 2. Examining the interaction between physiological and behavioral processes is essential to understanding individual variations in emotional and social development. Recently, researchers have been advocating for more studies that measure more than one regulatory mechanism. Calkins and Keane (2004) found that preschooler who display high and stable vagal suppression were less emotionally negative and demonstrated better social skills than children with low and irregular vagal suppression.

Diamond, Fagundes, and Butterworth (2012) found that adolescents with high levels of baseline vagal tone had the greatest empathic responsiveness. Increased vagal influence has also been associated with greater interest in the stimuli, less distractibility, and more adaptive emotional expression (Movius & Allen, 2004). Following in line with this research, it is hypothesized that (a) higher vagal suppression will be correlated with greater attention scores and positive affect. When preschoolers are learning emotional control, physical reactions to stimuli should decrease as the child learns to internalize regulatory processes. Based on previous research, (b) greater vagal suppression will be correlated with increased motor restriction because increased vagal influence is associated with optimal self-control behaviors.

Parental Expressivity Influence on Vagal Tone and Empathy Hypotheses

Hypothesis 3. How parents react to their children's emotional displays and how they regulate their own emotions in front of their offspring have important implications for how children process information and develop socio-emotional functioning. Parents with high expressivity scores on the Self-Expressiveness in Family Questionnaire (SEFQ) should influence their children's emotional expressiveness and emotional regulation. Since increases in vagal influence have been associated with the understanding of emotions, it is hypothesized that (a) parent's self-reported expressivity scores will positively correlate with higher toddler resting RSA ratings. It is also predicted that (b) higher positive and total parental expressivity scores will relate to increased displays of empathic behavior. Being able to appropriately react to others' emotions should be influenced by parent expressions of emotions because caregivers are typically the main socializing agent during toddlerhood.

Differences in Parental Expressivity Hypothesis

Hypothesis 4. A majority of the research on the development of socioemotional understanding has focused only on the mother-child relationship. However, in the current study, I plan on looking at both the mothers' and fathers' interactions with their offspring. Each person in this triadic relationship plays a specific role in the child's socialization of emotions. Previous research usually combined the mothers' and fathers' SEFQ scores to create a composite score of the parental emotion socialization (McElwain, Halberstadt, & Volling, 2007). Although the inclusion of both parents together is important to this study, the researcher also looked at the mother and father separately to look for unique contributions to the child's development. It is predicted that (a) mothers will have higher total expressivity scores on the SEFQ than the fathers because mothers are typically the primary caregivers and have more experience with emotional responding with the child. It is also hypothesized that (b) higher (more positive) scores on the SEFQ are related to the children's displays of empathy.

III. METHOD

Participants

The participants were drawn from the *Familial Influences on the Development of Empathy in Preschoolers*, a study that began in 2008 to examine preschoolers' empathy and emotional regulation and the familial socialization strategies between parent and toddler. From the original 119 preschoolers, 65 participants (36 males, 29 females) with both mother and father data sets were used to study the triadic family dynamic. On average, the preschoolers are 4 years of age (M = 4.16, SD= 0.60), with the youngest being 3 years old and the oldest participant being 6 years old. Fifty-five mothers or fathers labeled themselves as Caucasians (84.62%) , five identified themselves as Hispanics (7.69%), one labeled himself/herself as African Americans (1.54%), two identified themselves as Asians (3.08%), and two choose the label Other (3.08%). Relationship status was collected to look at family structure resulting in a self-report of 58 married parents (89.23%), 1 single parent (1.54%), 1 parent that had a significant other that was not the preschooler's father (1.54%), and 5 of the preschoolers' parents did not respond about their current relationship status (7.69%).

Measures

Behavioral Coding

Behavioral coding systems allow researchers to examine emotional expressions by breaking down specific movements and actions to determine precise emotional reactions and experiences (Izard, 1990). Graduate and undergraduate students conducted the behavioral coding. Inter-coder reliability was assessed on 10-15% of the participants by checking two independent coders' work for each measure. The behavior was coded using the Observer program, where keystrokes are used to assess magnitude and frequency of behavioral changes. Attention, Motor Activity, Vocal Response, Inquisitiveness (Hypothesis Testing), Affect through Facial Expression, External Display of Affect through Both Verbal and Facial Expressions, and Expressive Congruence were all separately measured. Appendix A describes how the coders assess each separate category.

Written Measures

Parents completed a battery of questionnaires on their mood, their child's mood, and their perceptions of their child's temperament. The current study focuses on solely the Self-Expressiveness in the Family Questionnaire (SEFQ; Halberstadt et al., 1995). Mothers and Fathers completed a 40-item version of the SEFQ. Parents rated how frequently they express emotions with family members on a 9-point scale from 1 (*rarely expresses feeling*) to 9 (*frequently expresses feeling*). Each question either fell into the positive (22 items), the negative-dominant (14 items), or the negative-submissive (4 item) category. The negative-dominant and the negative-submissive items were combined to compare the positive ratings with the overall negative ratings. There were five questions that had very low intra-item correlations compared to the other 35 items. Those five (Questions 10, 13, 14, 20, and 34) were not included in the final calculations. Ultimately, the averages for the positive scores, the negative scores, and the total overall expressivity scores were calculated from the 35 highly-correlated items from the original 40-item version of the SEFQ.

Cardiac Analysis

The initial raw data were quantified using the IBI Analysis System by The James Long Company (Caroga Lake, NY). The IBI Analysis System contains several physiological data acquisition programs, which run through a MS-DOS compatible system. Six of the programs in the IBI Analysis System were utilized. ECGRWAVE was applied using a minimal high-pass filter (no higher than .03Hz) four times to a self-scaling algorithm to extract R-wave peaks from the ECG analog channel. IBIEDIT allowed the researcher to open the ECGRWAVE data file containing the automatically-labeled R-spikes and manually edit any artifact. Artifact is the distortion of the heart period variability calculation that can occur during the manipulation of the raw data. All the screenings of artifact were done by hand to correct for any biases or errors. IBIEQUAL was used to compute the mean interbeat interval for each edited file and prorates the IBIs to an equal time interval of 125ms (8Hz). IBITREND filtered out periodic sources of variability that were not due to periodic sources by using a high-pass filter with a period of 5 seconds (roughly 0.2 Hz). This period of 5 seconds is typically used for children and is appropriate for the current age group being studied. IBISPECT reported spectral power and the mean square seconds within each epoch. 30 second epochs for a 3-5 minute episode have been labeled as appropriate for children (Calkins & Keane, 2004). However, the sampling rate for IBISPECT needed to be a multiple of 32, so the researcher used a 64 second sampling rate. A 64 sampling rate was used to ensure that there was at least 30 seconds for each epoch after all the artifact editing was complete. RSA was computed by looking at the difference between the minimum IBI during inspiration and the maximum IBI during expiration. The last program, IBIMEAN, calculated interbeat intervals and heart period variablities using at least 30 second epoch periods. The epochs were created for time series evaluations to figure out the differences in IBI (HP) and HPV between each epoch.

Composite Scores of the Percentages of Time in Each Emotional State

Composite scores were necessary because each behavior had specific characteristics that are considered optimal for both the happy and sad condition. The raw data needed to be adjusted to ensure that similar behaviors are coded together to fall more in line with the expected performance scores. For example, the category of Attention was composed of five different codes. Codes 5 and 4 got a weighted score of 3 because they had the highest ratings of focus and gaze direction which have been associated with attention. Codes 3 and 2 were linked with lower attentional ratings, so they received a weighted score of 2. Code 1 was weighted with the lowest score of 1 because it signified that the child was not paying attention during the task. The Affect through Facial Expression category had a strong emphasis on positive facial expressions for the happy story and less on the negative story. Codes 5 and 4 were weighted together to create the positive affect score of 3, and Codes 2 and 1 were weighted together to create the negative affect score of 1 for the happy conditions. Code 3 was neutral and was weighted with a 2. Since troubled facial expressions have more relevance during the sad story, the weighted codes were reverse scored for the sad condition. Since ideal motor reactivity movements should be less frequent once the child learns emotional regulation, the Motor Activity codes are reverse scored to create a new category labeled Motor Restriction. Codes 1 and 2 were weighted with a score of 3, whereas codes 5 and 4 were weighted with only a score of 1. Again, Code 3 had a weighted score of 2.

Empathic behavior was derived from combining the weighted scores of the two categories Hypothesis Testing and Expressive Congruence. The Hypothesis Testing category had three codes and Expressive Congruence had 2 codes. The three codes were standardized into two weighted scores. If the child asked questions about the story, the weighted score was 2. If the child asked a question unrelated to the story or did not ask a question, the weighted score was 1.The two codes for Expressive Congruence remained the same as the raw scores. If the affect and expressiveness was congruent with the story or discussion content, the weighted score was 2. If the affect and expressiveness was not congruent with the story or discussion content, the weighted score was 1. Although both the mothers' and the fathers' SEFQ scores were added up separately for individual assessments, both set of scores were also combined to form the parents' overall SEFQ score.

Procedure

Parents were recruited to participate with their child through the use of a research recruitment flyer left with teachers at various preschools in Palm Beach, Broward, and Martin Counties in Florida. Participation was strictly voluntary. RSA, heart period, and heart period variability was measured using an electrocardiogram (ECG). Three disposable self-adhesive electrodes (Lead-Lok, Inc.) were placed on the preschoolers' chest in an inverted triangle pattern. A 3-minute long baseline was taken while the child was asked to minimize motor activity. The baseline was taken to observe individual differences and to function as the control for the two emotional narrative tasks.

During the two short reading tasks, ECG was recorded, along with an 8mm video that would later be used for behavioral coding. The two stories were counterbalanced to avoid any possible biases due to disproportions in the order of the conditions. For the positive emotion condition, one happy story ("I Know a Rhino" or "The Crunching, Munching, Caterpillar") was chosen at random and read to the child by his or her mother. Following the story, each child had approximately one minute to discuss with his/her mother about the feelings that were evoked during the story and whether they liked the narrative. After the mother's discussion, heart-rate recording and taping ceased while the child was reoriented to a neutral state by the researcher. After a few minutes, the mother read the other emotional story. For the negative emotion condition, one sad story ("Goodbye Mousey" or "The Tenth Good Thing about Barney") was chosen at random and read to the child by his/her mother. Again, a discussion about how the child felt during the story was discussed with his/her mother. Following the completion of the mother-led conditions, the father completed the same reading and discussion tasks with the preschooler using the two remaining books with the order of the emotion conditions being switched (for example, if the happy story was read first by the mother, the father started with the sad story). After the father and child completed both of the story and discussion tasks, both parents were asked to fill out several questionnaires and a demographic sheet. An age-appropriate educational book and a participation certificate were given to each preschooler to conclude the home-visit.

IV. RESULTS

Preliminary Analyses

Intercorrelations were calculated to assess similarities across tasks prior to testing the proposed hypotheses. The preliminary analyses were run to ensure that the behavioral coding data were related across the different steps of the experiment. Attention, facial affect, and motor restriction composite scores were assessed across the mother-led and the father-led story and discussion tasks. Attentional and motor behaviors were correlated between story and discussion conditions for both the mother and father. In Table 1.0 and Table 1.1 significant correlations were found between attention paid and during the mother-led happy and sad stories, $r=.36$, $p=.004$, and discussions, $r=.39$, $p=.002$, and the motor restriction during mother-led happy and sad stories, $r=.73$, $p<.00$, and discussions, $r=.69$, $p<.00$. The nonsignificant correlations for facial affect (Table 1.2) during the mother-led happy and sad stories and discussions ranged from -.21 to .19.

In Table 1.3 intercorrelations were conducted for attention paid during the father-led happy and sad stories and discussion. Significant correlations were found between the happy and sad stories, $r=.36$, $p=.006$, and the happy and sad discussions, $r=.43$, $p=.001$. Table 1.4 illustrates the significant correlations between the happy and sad stories, $r=.65$, $p<.00$, and discussions, $r=.82$, $p<.00$, for the child's motor restriction. There was a significant relationship in the facial affect expression during father-led happy and sad stories, r=.59, p<.00, but not for the happy and sad discussions. The nonsignificant correlations for facial affect ranged from -.14 to .13.

Intercorrelations were conducted to compare empathic behavior variables for each task across the two parental conditions. Table 1.6 summaries the significant correlations for the empathic behavior during the mother-led happy and sad stories, r=.76, p<.00, and discussions, r=.46, p<.00. Table 1.7 displays the significant correlations in empathic behavior between the happy and sad stories, r=.41, p=.001, and happy and sad discussions for the father-led stories, r=.26, p=.056. The nonsignificant correlations for empathic behavior during father stories and discussions ranged from .15 to .20.

Table 1.0

Correlations for attention paid during mother-led happy and sad stories and discussions

Variables	Attention Sad Story	Attention Happy Story	Attention Sad Discussion	Attention Happy Discussion
Attention Sad Story	--	.36**	.52**	.17
Attention Happy Story		--	.20	.56**
Attention Sad Discussion			--	.39**
Attention Happy Discussion				--

Note: ** Correlation is significant, p<.01.

Table 1.1

Correlations for motor restriction during mother-led happy and sad stories and discussions

Variables	Motor Restriction Sad Story	Motor Restriction Happy Story	Motor Restriction Sad Discussion	Motor Restriction Happy Discussion
Motor Restriction Sad Story	--	.73**	.66**	.47**
Motor Restriction Happy Story		--	.51**	.47**
Motor Restriction Sad Discussion			--	.69**
Motor Restriction Happy Discussion				--

Note: ** Correlation is significant, $p<.01$.

Table 1.2

Correlations for facial affect during mother-led happy and sad stories and discussions

Variables	Facial Affect Sad Story	Facial Affect Happy Story	Facial Affect Sad Discussion	Facial Affect Happy Discussion
Facial Affect Sad Story	--	.06	.16	.11
Facial Affect Happy Story		--	.19	.39**
Facial Affect Sad Discussion			--	-.21
Facial Affect Happy Discussion				--

Note: ** Correlation is significant, p<.01.

Table 1.3

Correlations for attention paid during father-led happy and sad stories and discussions

Variables	Attention Sad Story	Attention Happy Story	Attention Sad Discussion	Attention Happy Discussion
Attention Sad Story	--	.36**	.28*	-.14
Attention Happy Story		--	.16	.17
Attention Sad Discussion			--	.43**
Attention Happy Discussion				--

Note: * Correlation is significant, p<.05, ** Correlation is significant, p<.01.

Table 1.4

Correlations for motor restriction during father-led happy and sad stories and discussions

Variables	Motor Restriction Sad Story	Motor Restriction Happy Story	Motor Restriction Sad Discussion	Motor Restriction Happy Discussion
Motor Restriction Sad Story	--	.65**	.60**	.60**
Motor Restriction Happy Story		--	.57**	.66**
Motor Restriction Sad Discussion			--	.82**
Motor Restriction Happy Discussion				--

Note: ** Correlation is significant, p<.01.

Table 1.5

Correlations for facial affect during father-led happy and sad stories and discussions

Variables	Facial Affect Sad Story	Facial Affect Happy Story	Facial Affect Sad Discussion	Facial Affect Happy Discussion
Facial Affect Sad Story	--	.59**	.57**	.13
Facial Affect Happy Story		--	.40**	.30*
Facial Affect Sad Discussion			--	-.14
Facial Affect Happy Discussion				--

Note: * Correlation is significant, p<.05, ** Correlation is significant, p<.01.

Table 1.6

Correlations for empathic behavior during mother-led happy and sad stories and discussions

Variables	Empathy Sad Story	Empathy Happy Story	Empathy Sad Discussion	Empathy Happy Discussion
Empathy Sad Story	--	.76**	.34**	.30*
Empathy Happy Story		--	.31*	.32*
Empathy Sad Discussion			--	.46**
Empathy Happy Discussion				--

Note: * Correlation is significant, p<.05, ** Correlation is significant, p<.01.

Table 1.7

Correlations for empathic behavior during father-led happy and sad stories and discussions

Variables	Empathy Sad Story	Empathy Happy Story	Empathy Sad Discussion	Empathy Happy Discussion
Empathy Sad Story	--	.41**	.15	.19
Empathy Happy Story		--	.20	.55**
Empathy Sad Discussion			--	.26***
Empathy Happy Discussion				--

Note: ** Correlation is significant, p<.01, *** Correlation is a statistical trend, p=.10.

Hypothesis 1: Heart Period Variability will be different for the Happy Story, the Sad Story, and the Baseline conditions

A Parent (Mother-led compared to Father-led) by Emotion-Type (Sad versus Happy) repeated-measures MANOVA was performed on the child's averaged heart period variability during both story tasks. The results show that there were significant differences between the happy and sad conditions for both the mother and the father. There was a main effect for emotion across the two tasks, $F(1,44)= 63.82$, $p<.00$, and a main effect for parent across the two tasks, $F(1,44)= 110.55$, $p<.00$. The results indicated that heart period variability was lower during the sad stories, (*M*=.04, SE=.01) than the happy stories *(M*=.17, SE. =.01). Moreover, the interaction effect between emotion type and parent was significant, $F(1,44)= 84.97$, $p<.00$, but only for the mother-led tasks. The child displayed the most vagal suppression during the mother-led sad story (*M*=.04, SE=.06), and the lowest vagal suppression during the mother happy story (*M*=.28, SE=.02) (See Figure 1.)

A series of paired-samples *t*-tests were run to look at differences in the standard deviation of children's IBI scores (HPV) for: 1) the baseline and the mother-led sad story, 2) the baseline and the father-led sad story, 3) the baseline and the average of the mother-led and father-led sad story tasks. There were no significant differences among the three tests. Table 2.0 shows the variable means for the baseline, the mother-led sad story, the father-led sad story, and the combined sad story conditions. The baseline had smaller HPV than any of the sad story conditions, suggesting that the preschoolers' HPV did not display the expected physiological change between the baseline and the stressful stimuli.

A repeated-measures MANOVA was run to determine whether the child had the higher heart period (smaller IBIs) during the story and discussion conditions than during the baseline. There was a statistical trend among the three conditions, F (2, 41) = 2.65, p=.076. The baseline had the lowest heart period (*M*=.63, SE= .02) followed by the happy conditions (*M*= .64, SE= .02). The sad conditions had the highest heart period (*M*= .65, SE= .02). Figure 2 depicts the means of the average heart periods across the baseline, the happy conditions, and the sad conditions. There results propose that heart period is a more accurate measurement for looking at the differences between the control and the experimental tasks.

Figure 1. Average heart period variability during the different conditions

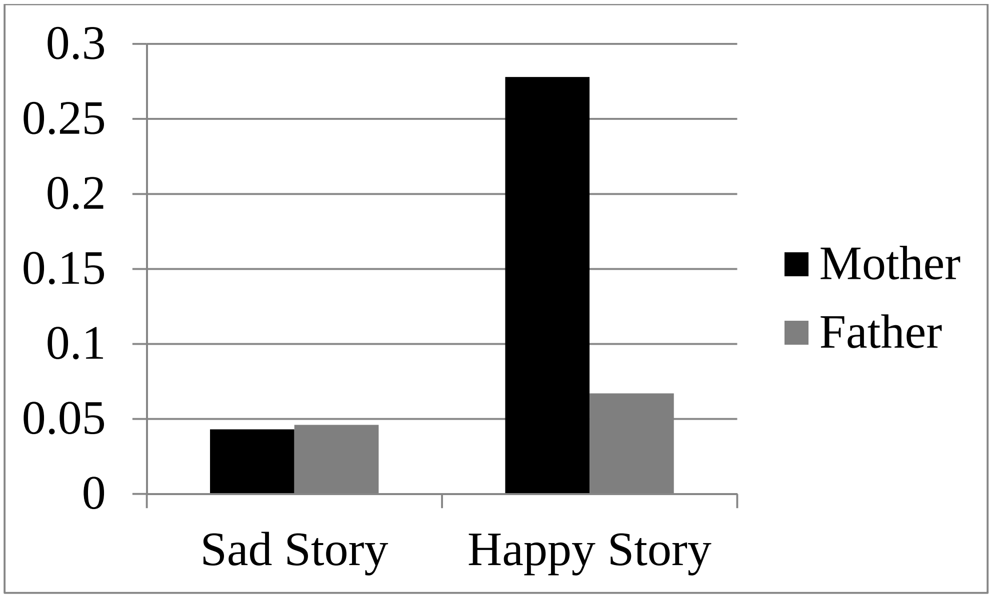
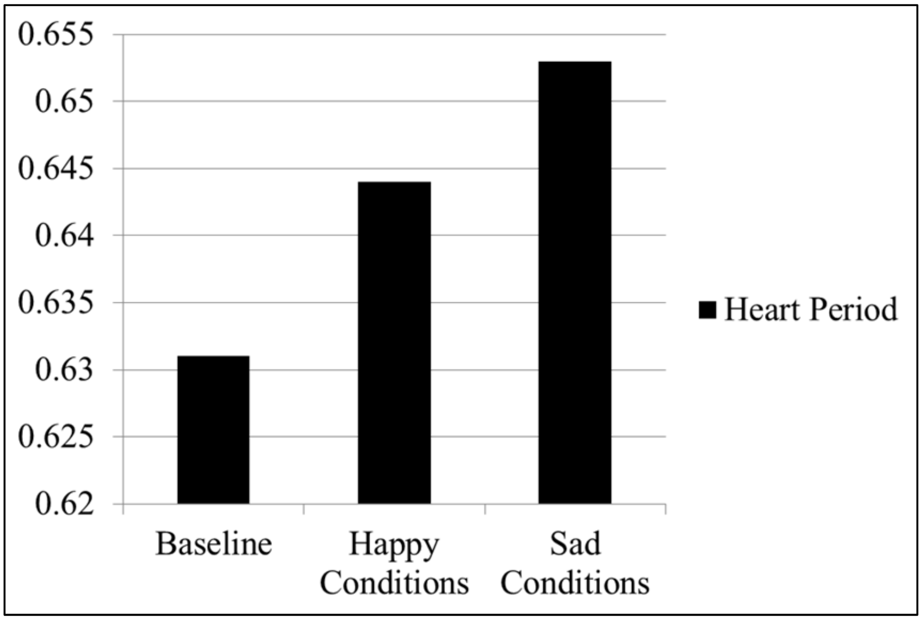


Table 2.0

Child's average heart period variability for baseline and mother-led sad story, baseline and father-led sad story, and baseline and combined parent sad story.

Pair	Conditions	N	Average of Child's Heart Period Variability
1	Baseline	51	.04 (.03)
1	Mother Sad Story	51	.04 (.03)
2	Baseline	47	.04 (.03)
2	Father Sad Story	47	.05 (.04)
3	Baseline	46	.04 (.03)
3	Combined Sad Story	46	.05 (.03)

Figure 2. Average heart period during the three conditions



Hypothesis 2: Greater vagal suppression will correlate with greater attention scores, facial affect, and greater motor restriction.

Pearson correlations were run to determine whether the physiological processes corresponded to the predicted optimal behaviors. It was predicted that the preschoolers' RSA would be negatively correlated to greater attention scores, facial affect, and motor restriction. The child's averaged RSA during the sad story conditions was significantly negatively correlated with attention scores during the father-led sad discussion, $r=-.40$, $p=.010$. Vagal suppression was related to greater attention scores when the father discussed the sad story with the child. There were no other significant relationships found between the child's RSA during the story and discussion tasks and the composite scores of facial affect and motor restriction. The nonsignificant correlations ranged from -.22 to .15.

Follow-up Pearson correlations were conducted to see if there was a relationship between the child's baseline RSA and predicted attention, facial affect, and motor restriction scores. It was hypothesized that the children's baseline RSA would be positively correlated with greater attention scores, facial affect, and motor restriction. The children's RSA was positively correlated with the child's motor restriction during the mother-led sad discussion, r=.31, p=.04. There was also a significant positive relationship between the children's RSA and the motor restriction for father-led happy story, r=.33, p=.03. No other variables had a significant relationship. Higher baseline RSA (vagal tone) is associated with appropriate levels of motor reactivity.

A series of Parent (Mother-led compared to Father-led) by Emotion (Sad versus Happy) by Condition (Story versus Discussion) MANOVAs were run to determine how the behavioral processes differed between the different tasks for: 1) attention, 2) facial affect, and 3) motor restriction (Figures 3 and 4). For attention, there was a significant emotion effect, F(1,53)=33.06, p<.00, and a significant condition effect, F(1,53)=15.77, p<.00. The children paid greater attention during the happy conditions (*M*=96.08, SE=.70) than the sad conditions (*M*=90.08, SE=.70). Greater attention was paid during the stories rather than the discussions (*M*=95.71, SE=.60). However, there were no significant interactions between the emotion and condition factors.

For facial affect, there was a significant emotion effect, F (1, 53) =11.29, p=.001, with the children displaying more positive affect during the happy tasks (*M*= 71.65, SE=.93) compared to the sad tasks (*M*= 67.96, SE=.91). More importantly, there were many significant interaction effects between emotion and parent, F(1,53)= 5.07, p=.028, between emotion and condition, $F(1,53)=7.99$, $p=.007$, and between parent, emotion, and condition, $F(1,53)= 4.10$, $p=.048$. The preschoolers displayed the most appropriate displays of affect during the discussion of the happy story for both the mother (*M*=70.57, SE= 1.6) and the father (*M*=75.75, SE=1.36), and the least appropriate displays of affect during the discussion of the sad story for both the mother (*M*=67.91, SE=1.24) and the father (*M*=65.92, SE=1.55).

For motor restriction, there was significant condition effect, $F (1, 53) = 55.12$, $p<.00$. There was more optimal motor restriction during the story (*M*=87.94, SE=1.82) than the discussion (*M*=75.62, SE=2.57). A statistical trend for the emotion effect was found, $F (1, 53) =2.89$, $p=.095$. There was more motor restriction during the happy tasks (*M*= 82.69, SE=2.08) than the sad tasks (*M*=80.88, SE= 2.19). There were no significant interactions found between the emotion and the condition factors.

Figure 3. Average percentage of attention, facial affect, and motor restriction ratings for children when interacting with mother

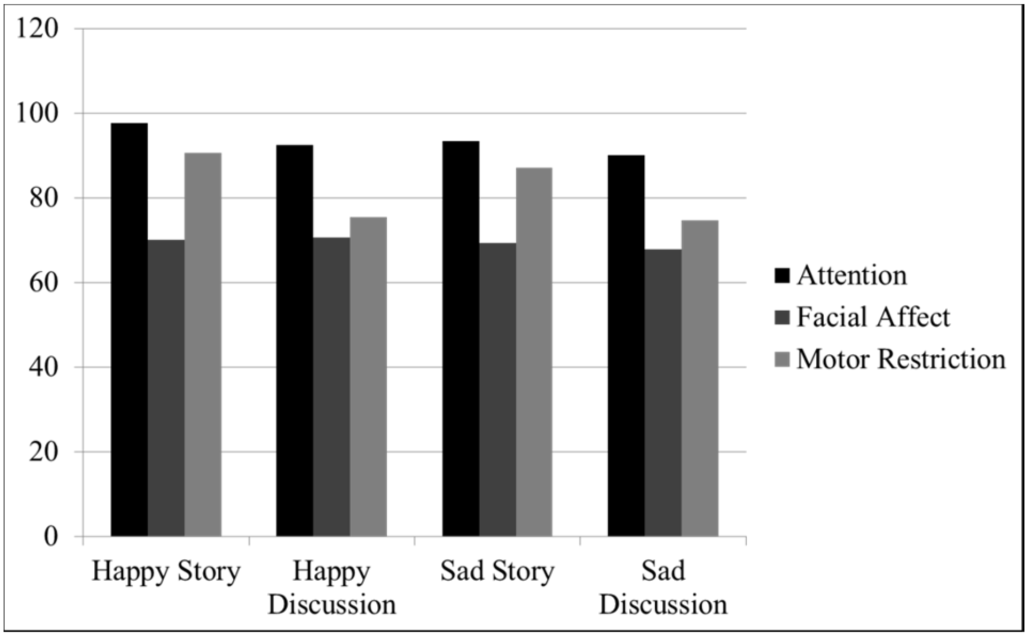
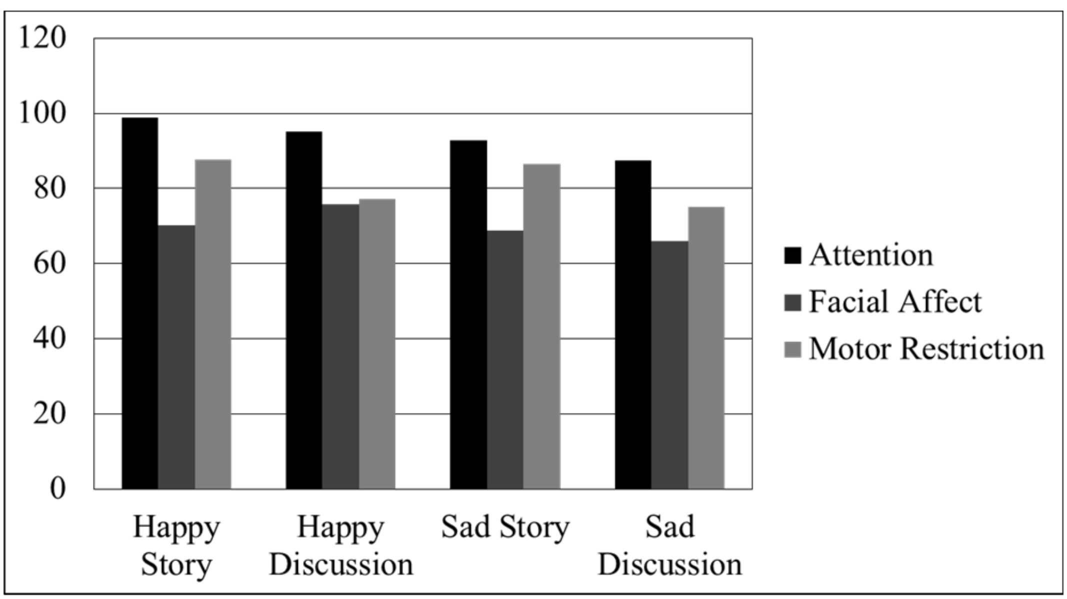


Figure 4. Average percentage of attention, facial affect, and motor restriction ratings for children when interacting with father



Hypothesis 3: Parental self-rated expressivity scores should influence the child's vagal regulation and empathic behavior.

A series of Pearson correlations were run to compare the parent's positive, negative, and total expressivity with the child's RSA data across all conditions (See Table 3.0). Significant correlations were found between the child's averaged RSA across the parents' happy conditions and the parent's combined total SEFQ score, $r=-.31$, $p=.034$. There was a significant relationship between the preschoolers' averaged RSA during the father-led happy tasks and the combined parental total SEFQ self-rating, $r=-.31$, $p=.03$. Additionally, there was a statistical trend between the preschoolers' averaged RSA during the father-led happy tasks and the combined parental positive SEFQ ratings, $r=-.25$, $p=.084$. The nonsignificant correlations ranged from -.24 to .20.

A series of Pearson correlations were conducted to determine whether the parent's combined positive, negative and total expressivity was related to the children's empathic behavior during the emotional-evocative conditions. There were no significant correlations between combined positive, negative, and total parental SEFQ self-ratings and the preschoolers' displays of empathy. A Parent (Mother-led compared to Father-led) by Emotion (Sad versus Happy) by Condition (Story versus Discussion) MANOVA was executed to see how empathic behaviors differed between the different tasks (See Figure 5). There was a significant emotions effect, $F(1,53)= 21.99$, $p<.00$, with the child displaying more empathy during the happy conditions (*M*=73.78, SE=.46) than during the sad tasks (*M*= 71.64, SE=.64). A statistical trend was found for the condition effect, $F(1,53)=3.40$, $p=.071$. Preschoolers' displayed more empathic behaviors during the stories (*M*= 73.31, SE=.55) than the discussions (*M*=72.12, SE=.65). Moreover, there was a statistical trend for the emotion by condition interaction, F (1, 53) =-3.35, p=.073. The children exhibited the least amount of empathic responses during the sad discussions (*M*=70.70, SE=.50) and the most empathic responses during the happy stories (*M*=74.03, SE=.50).

Multiple regression analyses were conducted to examine if the parents' combined self-reported expressivity scores (Model 1: Positive and Negative, Model 2: Total) predicted child's empathic behaviors during 1) mother-led sad story task, 2) mother-led sad discussion task, 3) mother-led happy story task, 4) mother-led happy discussion task, 5) father-led sad story task, 6) father-led sad discussion task, 7) father-led happy story task, and 8) father-led happy discussion task. The overall model for Model 2 explained a significant proportion of the variance (26.7%) for empathy during mother sad story, R^2=.27, F(3,63)=7.30, p<.00. Three predictors emerged from the data. The positive self-expressiveness index (*b*=.78, *t*(63)=4.23, p<.00) and the negative self-expressiveness index (*b*=.69, *t*(63)=3.71, p<.00) had a positive relationship with the children's empathic behavior. The combined total expressivity score (*b*=-1.13, *t*(63)=-4.57, p<.00) had a negative relationship with the preschoolers' displays of empathy.

The overall model for Model 2 explained a significant proportion of the variance (19.3%) for empathy during mother happy story, R^2=.19, F(3,62)=4.71, p=.005. Three predictors emerged from the data. The positive self-expressiveness index (*b*=.65, *t*(62)=3.35, p=.001) and the negative self-expressiveness index (*b*=.61, *t*(62)=3.13, p=.003) were positively related with the preschoolers' empathic behavior. The combined total expressivity score (*b*=-.96, *t*(62)=3.66, p=.003) had a negative relationship with the children's displays of empathy. There were no other significant models or predictors of child empathy during the mother-led discussions or the father-led tasks.

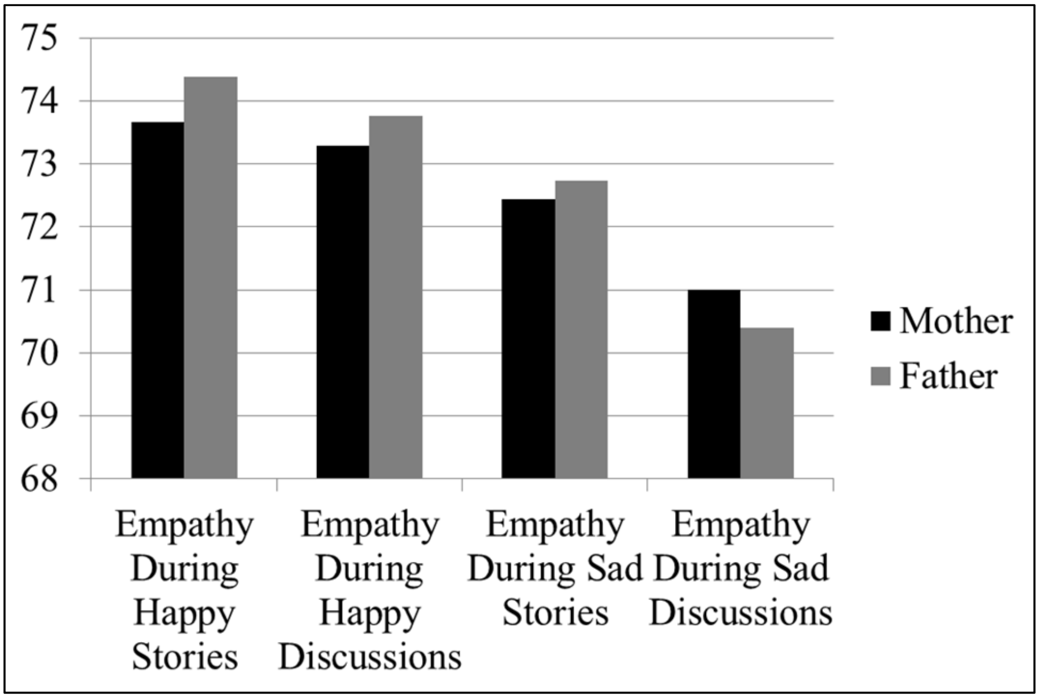
Table 3.0

Correlations between the Parent SEFQ score and the children's averaged RSA across the three conditions

	Parent Combined Positive SEFQ	Parent Combined Negative SEFQ	Parent Combined Total SEFQ
Child's Averaged Baseline RSA	-.12	-.19	-.20
Child's Averaged Sad RSA	.05	.14	.11
Child's Averaged Happy RSA	-.24	-.23	-.31*
Child's Averaged Sad RSA during Mother Tasks	.05	.15	.12
Child's Averaged Happy RSA during Mother Tasks	.10	.20	.19
Child's Averaged Sad RSA during Father Tasks	-.01	-.14	-.12
Child's Averaged Happy RSA during Father Tasks	-.25***	-.22	-.31*

Note: *Correlation is significant, p< .05, *** Correlation is a statistical trend, p=.10.

Figure 5. Average empathic behavior for children across the different tasks



Hypothesis 4: Mothers and fathers will have different expressivity self-ratings and those differences will influence the preschoolers' empathic behaviors.

A series of Pearson correlations were run to compare the mothers' positive, negative, and total expressivity ratings with the children's empathic responses across all of the mother-led conditions (See Table 4.0). There was a significant negative relationship between mothers' total expressivity score and the child's empathy during the sad story task, r= -.27, p=.028. The nonsignificant correlations ranged from -.17 to .12. Another set of Pearson correlations were run to compare the fathers' positive, negative, and total expressivity ratings with the preschoolers' displays of empathy across all of the father-led tasks (See Table 4.1). A significant negative relationship was found between the fathers' positive expressiveness scores and the children's' empathic behaviors during the happy discussion, r=-.26, p=.042. The nonsignificant correlations ranged from -.12 to .17.

A Parent (Mother-led compared to Father-led) by SEFQ score (Positive, Negative, or Total) MANOVA was conducted to find out how SEFQ scores differed between both the mother and the father. A significant parent effect was found, F(1,64)=6.00, p=.017, with mothers describing themselves as more expressive (*M*=5.39, SE=.12) than fathers (*M*=5.04, SE=.11). Additionally, there was a significant parent by SEFQ interaction, F(1,64)= 11.68, p=.001, with mothers scoring higher on the positive items of the SEFQ (*M*=6.84, SE=.15) than the fathers (*M*=6.16, SE=.15). The mothers in the study had higher overall expressivity scores than the fathers (See Figure 6).

Multiple regression analyses were conducted to examine if mother self-reported expressivity scores (Model 1: Positive and Negative, Model 2: Total) predicted the child's empathic behaviors during: 1) mother-led sad story task, 2) mother-led sad discussion task, 3) mother-led happy story task, and 4) mother-led happy discussion task. The overall model for Model 2 explained a significant proportion of the variance (17.8%) for empathy during the mother sad story, R^2=.18, F(3,60)=4.34, p=.008. There were two significant predictors that emerged from the analysis. The positive self-expressiveness index for mothers (*b*=.44, *t*(60)= 2.65, p=.01) was shown to have a positive relationship with the preschoolers' empathic behaviors, while the total self-expressiveness index for mothers (*b*=-.74, *t*(60)=-3.43, p=.01) had a negative relationship with the children's empathy. The negative self-expressiveness index for mothers does not appear to have a unique contribution to the overall model. No other regression analyses were significant for the mother conditions.

Multiple regression analyses were conducted to examine if father self-reported expressivity scores (Model 1: Positive and Negative, Model 2: Total) predicted the child's empathic behaviors during: 1) father-led sad story task, 2) father-led sad discussion task, 3) father-led happy story task, and 4) father-led happy discussion task. The overall model for Model 1 explained a significant proportion of the variance (12.1%) for empathy during the father happy discussion, R^2=.12, F(2,57)=3.93, p=.025. There was one significant predictor that emerged from the analysis. The positive self-expressiveness index for fathers (*b*=-.31, *t*(57)= -2.43, p=.018) was shown to have a negative relationship with the preschoolers' empathic behaviors. There was a statistical trend for the negative self-expressiveness index for fathers predictor. There was a positive relationship between the negative expressivity ratings for fathers (*b*=.23, *t*(57)=1.83, p=.072) and the child's empathic behaviors. For the overall model for Model 2, there was a statistical trend for empathy during the father happy discussion, R^2=.13, F(3,56)=2.66, p=.057. However, there were no significant predictors that appeared to have a unique contribution to the overall model.

Table 4.0.

Correlations between the mothers' SEFQ score and the children's empathic responses across the three conditions

	Mother Sad Story	Mother Sad Discussion	Mother Happy Story	Mother Happy Discussion
Mother Positive Expressivity Rating	.01	.12	.02	-.07
Mother Negative Expressivity Rating	-.12	.07	-.11	-.10
Mother Total Expressivity Rating	-.27*	.09	-.17	-.13

Note: *Correlation is significant, $p < .05$

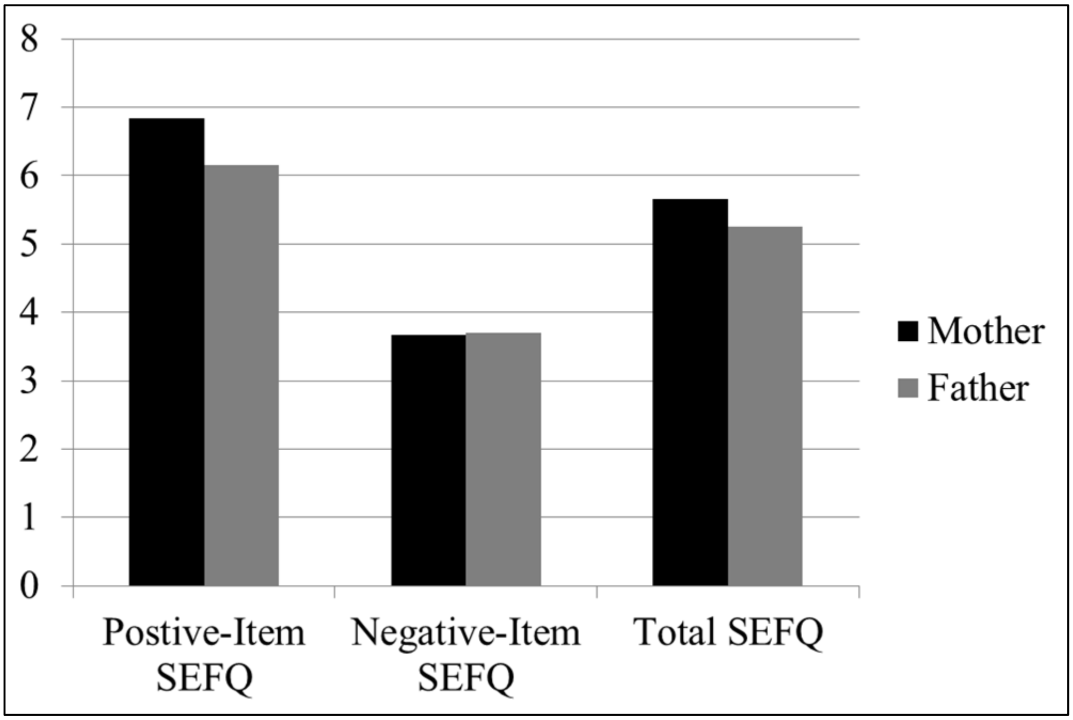
Table 4.1.

Correlations between the fathers' SEFQ score and the children's empathic responses across the three conditions

	Father Sad Story	Father Sad Discussion	Father Happy Story	Father Happy Discussion
Father Positive Expressivity Rating	-.01	-.004	-.12	-.26*
Father Negative Expressivity Rating	.04	-.02	.11	.17
Father Total Expressivity Rating	.01	-.02	-.02	-.10

Note: *Correlation is significant, $p < .05$

Figure 6. Comparison of mother and father SEFQ positive-item, negative-item, and total scores



V. DISCUSSION

Overview

Emotion regulation is a network of both intrinsic and extrinsic mechanisms that contribute to emotional self-management. Studying empathic and temperament regulation at a behavioral level and biological regulation through cardiac assessment, the researcher can explore emotional responses through multiple methods to get a comprehensive understanding of the development of self-regulatory skills. Emotional responses express how a person perceives everyday experiences, and understanding how individuals observe the world around them will allow individuals to acquire social and emotional competence. Preschoolers were chosen because early childhood is a remarkable time when children are learning to break away from their dependence on their caregivers. However, as children are beginning to gain self-control of their emotions, they still rely on parents to help shape their self-regulation strategies.

The present study examined psychophysiological differences in preschoolers during the baseline condition, a happy story and discussion, and a sad story and discussion. The emotionally-evocative tasks were used to compare whether the children displayed different cardiac patterns for the two emotions. It was hypothesized that the children’s heart period variability would be different between the happy story and the sad story and that the HPV would be lower during the sad story. It was believed that negative emotions would result in lower HPV because negative emotions are unique and require more management compared to positive emotions (Denham, 1998). Additionally, we hypothesized that the preschoolers would have the shortest interbeat intervals during the sad story, suggesting that the sad condition requires suppression of vagal tone.

Most studies report on behavioral and physiological regulation as two separate mediating processes. However, it has been suggested that physiological components may be one underlying mechanism by which self-control functions become manifested and observed through behavioral regulation (Liew, Johnson, Smith, & Thoemmes, 2011). Suppression of RSA during stressful situations is related to better state regulation, greater self-soothing, and more attentional control in infancy (Huffman et al., 1998). Based on previous findings, we hypothesized that more vagal suppression will be correlated with greater attention scores and positive affect. Effortful control is temperament-based and voluntary control over behavioral tendencies and inhibitory mechanisms (Rothbart & Bates, 2006). With that said, it was hypothesized that greater vagal suppression would be correlated with motor restriction because physical reactions should decrease as the preschoolers start to develop self-control.

Past research has demonstrated that more positive parental expressivity is positively related to a child's physiological control. Parents act as main socializing agents early in the child's life. How a parent reacts to emotional situations should influence how the child handles emotional evocation and develops socio-emotional understanding. It was proposed that parent's self-reported expressivity scores will positively correlate with higher resting RSA ratings. We also hypothesized that higher parent positive and total expressivity would increase the preschoolers' displays of empathic behaviors. Children learn how to experience others' emotional state by being exposed to parent's emotional expressiveness. Although it is important to look at both parents overall levels of expressivity, we also wanted to see how each person in the triadic relationship effect the child's socio-emotional development. We had hoped to add the relatively limited literature on the father's unique role in the child's emotional regulation. We wanted to look at the mother and father separately to determine whose expressivity scores were highest and whose expressivity scores predicted the child's empathic behavior. We hypothesized that the mothers would have higher expressivity scores on the SEFQ than the fathers and would have a significant influence on the child's empathy because mothers typically spend the most time with the child.

Increases in vagal suppression occurred during the sad story and discussion suggesting that negative emotions require more processing strategies. Greater attentional scores were related to the child's RSA and higher resting RSA was associated with less motor reactivity. The mothers had higher and more positive SEFQ scores than the fathers. However, there were no significant relationships found between parental expressivity ratings and child empathic responses. Mother and father ratings of emotionality were very different from each other, suggesting that both parents play a unique role in the child's development.

Hypothesis 1: Heart Period Variability will be different for the Happy Story, the Sad Story, and the Baseline conditions

Average heart period variability was different between the happy and sad conditions, with the heart period variability lower during the sad stories. These findings are consistent with the literature suggesting that negative emotions require more control compared to positive emotions (Lagattuta & Wellman, 2002). Positive emotions are talked about in daily life more than negative emotions. Increases in vagal suppression, which result in lower HPV, might be required to comprehend the intense and less familiar emotion.

The children's vagal suppression differed during the mother-led and father-led tasks, but only during the happy conditions. The mother-led and father-led sad tasks showed a similar expected pattern of lower HPV. The child's physiological mechanisms revealed the most optimal responses during the mother-led sad conditions, but the least optimal responses during the mother-led happy tasks. The children might have shown the most regulation during the mother-led sad tasks because the mother might communicate more about appropriate emotional responses and might spend the most time with the child as the primary caregiver. Happy emotions are often discussed frequently in daily life and are more familiar than negative emotions. Possibly the preschoolers did not have to regulate as much as expected with the mother during the happy conditions because conversing about happy emotions might be something the mother and child discuss frequently. However, the children did regulate during the father-led happy task. This might suggest that the fathers typically do not read to the child or discuss the different emotions as often as the mothers.

The children's heart period during the sad conditions and the baseline were compared to determine if the child had a higher heartbeat during the sad stories. The hypothesis was supported, the preschoolers' heart period was higher during the sad story than the baseline. The children's' IBIs got shorter as there was a shift in focus from internal homeostatic demands to condition demands that require internal processing of emotional stimuli. The psychophysiological processes did respond as predicted for the three conditions, with greater heart period during the task that requires more complex processing strategies. These results are consistent with previous literature (Calkins & Fox, 2002) and indicate that preschoolers display appropriate physiological responses when engaging emotion-driven situations.

Emotional processing in preschool-aged children is intrinsically modulated and this biological component plays an important role in the child's development of emotional regulation. The preschoolers required more physiological regulation during the sad stories and discussions because negative emotional themes are more difficult to comprehend than positive emotional or neutral themes. Nonetheless, these results suggest that mothers and fathers do influence the child's processing during the stimuli. The amount of time each parent interacts the child and communicates about the different emotions seems to affect the children's level of regulation during emotionally-evocative tasks.

Hypothesis 2: Greater vagal suppression will correlate with greater attention scores, positive affect, and greater motor restriction.

The interaction between physiological and behavioral processes was examined by looking at the relationship between temperament-influenced behaviors and the child's averaged RSA. A significant relationship was found between the child's RSA during the sad story conditions and the attention scores during the father-led sad discussion. It is possible that the child's internal regulation during the story manifested into greater attention scores during the discussion of the sad story. However, no significant effects were found for facial affect and motor restriction. There is a possibility that other behaviors, such as level of arousal, mediated the relationship between the behavioral and the cardiac activity during the emotion-provoking tasks. Also, it is possible that physiological and behavioral processes were not activated simultaneously during the different emotional conditions. Physiological mechanisms might have to occur before the behavioral responses can be manifested. This might explain why cardiac responses confirmed appropriate emotional processing, but were not related to facial affect and motor restriction during the conditions.

The relationship between the child's behaviors and the child's baseline were compared since high resting RSA has been associated with favorable behavioral outcomes for infants (Thompson, Lewis, & Calkins, 2008). The child's RSA was positively related with motor restriction during the mother-led sad discussion and the father-led happy story. High resting RSA was correlated to higher motor restriction, which suggested that children with higher baseline RSA did have more physical self-control during the conditions. Low resting RSA is a strong predictor of externalizing problems, so having higher baseline RSA could protect a child from developing behavior problems. Nevertheless, there were no significant correlations between the children's resting RSA and attention and facial affect. These results are not consistent with previous literature that has concluded that resting RSA is related to greater attention responses and greater of regulatory behavioral processes (Thompson, Lewis, & Calkins, 2008). It is possible that the children were paying attention, but were not displaying typical patterns of focused attention. Coherence of physiology and behavior has been difficult to determine because the findings have been mixed. The behavioral coding is somewhat subjective and focuses on eye gaze to determine whether the child is engaged in the task. There is a possibility that the children averted their eyes in order to regulate the emotions being processed. Future research should look at attentional responses further to determine if there is a pattern of attentional deflection in order to process emotional content during a particular stage in emotional management.

Attention, facial affect, and motor restriction were assessed to see if there were any differences between the tasks for each parent-child pair. Children paid greater attention during the happy conditions, especially during the happy stories. Happy emotions are easier to grasp because positive emotions are usually not intense or unpleasant (Duan, 2000). The preschoolers might have paid more attention to the story because it was easier to follow and more fun to read. More positive affect occurred during the happy tasks. The preschoolers showed more appropriate facial affect during the discussions of the happy stories for both the mother and the father. The results show that the preschoolers understood the stories and made appropriate facial expressions during the happy conditions. The child might have smiled and laughed more during the discussions because the focus was more on them and their feelings of the books during the discussions with the parents.

Lastly, there was more motor restriction during the stories than the discussions. Motor inhibition has been linked to effortful control, which allows an individual to cope and plan during stressful situations (Rothbart, Rueda, Sheese, & Posner, 2011). Although both tasks require regulation, the child might have required more self-control strategies during the story to better assess the plot of the books and the different emotions within the stories. The discussions were used to reiterate what had happened in the books and the children's opinions of the stories. Actually experiencing other's emotions might require more emotional regulation than discussing how the themes of the stories made the individual feel.

Although there were interactions between physiological and behavioral processes, the pattern did not match up with our expectations. We predicted that the physiological and behavioral component would be synchronized. Instead our results suggested that physiological regulation might occur before the expected behavioral response. Appropriate changes in RSA during the baseline and the stimuli were related to higher attentional scores and greater motor restriction, but only for some of the conditions. For this experiment, facial affect was not related to the cardiac measures. Further research is needed to find out how heart rate and facial affect are related.

Hypothesis 3: Parental self-rated expressivity scores should influence the child's vagal regulation and empathic behavior.

There was a significant negative relationship between the preschoolers' averaged RSA during the father-led happy stories and discussions and the combined parental SEFQ self-rating. Vagal suppression occurred more during the father-led happy tasks for subjects with parents who had higher (more positive) overall SEFQ ratings. The combined parental SEFQ is the parents' average of their total score on the SEFQ. The positive and negative categories were averaged and combined to see if the parents typically displayed more positive or more negative expressivity around the child. Moreover, the child's RSA when interacting with the father during the happy discussion was also negative correlated with more positive parental expressivity ratings. Although the correlations were small, the children's physiological reactions matched with the parent's positive expressivity during a happy task, suggesting that the parents' displays of positivity are associated with appropriate cardiac functioning during the more positive task. Liew, Johnson, Smith, and Thoemmes (2011) suggested that parental expressivity significantly influences the child's physiological response and that high levels of parental positive expressivity lead to optimal levels of regulation. Our results show that both intrinsic and extrinsic processes play an important role in preschoolers' emotional socialization and that further research is needed to understand how each component shapes children's emotional development.

We expected the child's cognition to be matured enough to talk about current emotional states with the parents. Internal processes required for the development of empathy involve both cognitive and emotional components (Hinnant & O'Brien, 2007). Hypothesis Testing and Emotional Congruence were combined to assess the preschoolers' ability to partake in perspective taking and appropriate emotional understanding. Contrary to our predictions, there were no significant relationships between the children's empathic behaviors and the parents' combined SEFQ self-ratings. The children might have been feeling certain emotions, but did not know to ask questions during the stories. Possibly empathic behaviors were occurring, but there might have been another measurement that explained the children's empathy better. Nonetheless, our analyses revealed that there were differences in preschoolers' empathic behaviors during the different tasks. Children displayed more empathic behaviors during the happy conditions than the sad conditions. The trending interaction between emotion and condition showed that the children were more empathic during the happy conditions. Duan (2000) proposed that individuals might be more intrinsically motivated to empathize with someone who feels pleasant emotions because pleasant emotions require a lower sacrifice, are more familiar, and are more pleasurable than with empathizing with someone who feels unpleasant emotions. The level of motivation and level of pleasantness might have affected how much empathic behavior was displayed by the preschooler during the different tasks.

The parents' averaged SEFQ ratings were related to the children's physiological measures during the happy conditions. Parents who scored higher on the positive expressivity scores had children who displayed more vagal suppression during the emotional stimuli. The combined expressivity self-ratings were not related to the preschoolers' empathic behavior. These results suggest that when both parents' SEFQ scores are combined, their scores predicted the children's proper cardiac responses, but not the children's displays of empathy.

Hypothesis 4: Mothers and fathers will have different expressivity self-ratings and those differences will influence the preschoolers' empathic behaviors.

As predicted, mothers described themselves as more expressive for both the positive and the overall ratings of the SEFQ. Fathers scored higher on the negative expressivity ratings, which was expected because fathers generally display less supportive responses to negative emotion. The current study decided to use the shortened version of the SEFQ, because we were only interested in looking at positive versus negative expressivity. However, one study suggested that fathers who display negative dominant expressivity during child interactions had children who avoided others at preschool, which could affect the preschoolers' social functioning (Carson & Parke, 1996). It would be interesting to see how the participants' parents would have scored if we had used the original form with positive, the negative-dominant, or the negative-submissive categories. We would expect that the child whose father rated high on the negative-dominant scale would have more atypical cardiac and behavioral regulations.

The self-reported SEFQ scores were examined to see if the expressivity ratings predicted the child's empathic behaviors during the different story and discussion tasks. The mothers' expressivity ratings did explain the child's empathy during the mother-led sad story. Mothers with higher positive expressiveness ratings had children who showed more empathic behaviors. Interestingly, mothers with lower total expressivity scores had children who showed more empathy. The fathers' positive self-expressivity had a negative relationship with the preschoolers' empathic behavior for the father-led happy discussion. The father's negative SEFQ scores were also positively trending with the child's displays of empathy. Children displayed more empathic responses during the happy discussion when the father scored lower on the positive category and higher on the negative category for the SEFQ. McElwain, Halberstadt, & Volling (2007) postulated that varying levels of mothers' and fathers' emotionality is associated with optimal child outcomes. Experiencing both positive and negative levels of emotion-related behaviors might lead to a better understanding of the different emotions and how to cope with challenging situations.

Mothers and fathers did have different expressivity self-ratings. Those differences did influence the preschoolers' empathic behaviors. Higher maternal positive, lower maternal total, and lower paternal positive SEFQ self-ratings significantly predicted children's empathic behaviors. These results suggest that mother and father reactions to emotionality vary and that each relationship in the family triad uniquely contributes to the socio-emotional competence in preschoolers.

Conclusions

The present study supports psychophysiological evidence that physiological regulation occurs as cardiac patterns change from resting states to emotion-provoking tasks. More vagal suppression was seen in the sad conditions, followed by the happy conditions. Baseline vagal tone had the lowest vagal suppression which signified the internal state of equilibrium metabolically. When the children were exposed to the emotion-evocation paradigms, children displayed appropriate responses suggesting internal self-control. However, this study did not demonstrate dramatic behavioral and physiological interactions. Greater attention was found during the sad discussions and motor restriction was related to the children's resting RSA. The discussion helped stimulate appropriate attentional control which is necessary for emotional understanding of other's experiences. The results suggested that parents' SEFQ ratings may not be as indicative of the empathic responses as we anticipated. However, the parents' self-expressivity ratings did relate to appropriate vagal responses. Higher ratings of parental expressivity scores indicated lower RSA measurements and greater vagal suppression for the preschoolers. There were differences between mothers and fathers’ expressivity scores, with mothers having the highest score for positive expressiveness and total expressiveness. The fathers had the highest score for negative expressiveness. Although there were only a few significant predictors, the separate maternal and paternal SEFQ scores did predict empathic behaviors. One limitation of using the SEFQ is the reliance on self-report measures to determine the maternal and paternal expressiveness. Although there were high intra-item correlations between the SEFQ ratings, future research needs to be conducted to see if other forms of measuring expressivity reproduce similar results.

These findings contribute to our understanding of emotional regulation in children. This study looked at multiple intrinsic and extrinsic pathways for the development of emotional regulation and the development of empathy. Although some results were subtle, this study contributed to the limited literature on biological and behavioral interactions during emotionally-eliciting conditions and on maternal and paternal differences in expressing emotions in social settings.

APPENDIX A

Second-by-Second Child Behavior Coding Descriptions

Title	Code	Behavior Descriptions
Attention/Focusing/Visual Gaze Direction		
	5	Child looks intently at book and is focused on book (or on parent)
	4	Child is momentarily distracted but then focused/concentrating on the story
	3	Child's focus wavers (shifts) on and off the book
	2	Child is focused on other things and only occasionally in focusing on the book
	1	No focused attention on the book
Motor Activity/Motor Reactivity		
	5	Frequent movements of several body parts at once, child cannot sit still
	4	Movement during the story, but less intense
	3	Occasional movement
	2	Few movements that are less intense (may not be repeated, like holding mother's hand)
	1	No movements
Verbal/Vocal Statements		
	3	Verbal comments about story
	2	Listening to parent during the story or discussion
	1	Comments are unrelated to the story
Hypothesis Testing/Inquisitiveness		
	3	Child asks questions about story
	2	Child asks questions unrelated to story
	1	Child asks no questions

Affect through Facial Expression		
	5	Child shows very positive facial expressions (laughing, bearing smile)
	4	Child shows somewhat positive facial expressions (smile)
	3	Child's facial expressions are neutral
	2	Child shows somewhat negative facial expressions (furrowed brown, grimaces)
	1	Child shows very negative facial expressions (pouting, sad, very troubled)
External Display of Affect through Verbal and/or Facial Expressions	4	Affective reaction is expressed in story through verbal and facial means together
	3	Affective reaction is expressed in story through verbal means only
	2	Affective reaction is expressed in story through facial means only
	1	Neutral verbal and facial expressions
Affective/Expressive Congruence		
	2	Affect and expressiveness is congruent with the story or discussion content
	1	Affect and expressiveness is not congruent with the story or discussion content

APPENDIX B

40-Item Self-Expressiveness in Family Questionnaire

Instructions

This is a questionnaire about family expressiveness. We'd like to know more about the degree of expressiveness shown in different families. Therefore, we'd like you to tell us about the frequency of expression in your family while you were growing up. By frequency we mean, "How often does this situation occur in your family, relative to other families?"

Try to think of the following scenarios in terms of how frequently they occurred in your family, compared to other families, while you were growing up. Use the rating scale below to indicate how frequently that activity occurred. Thus, if a situation rarely occurred, or occurred not at all frequently, circle 1, 2, or 3. If it occurred with some or moderate frequency, circle a 4, 5, or 6. And if it occurred very frequently, circle a 7, 8, or 9.

Some items may be difficult to judge. However, it is important to answer every item. Try to respond quickly, but not randomly. Thank you very much.

1. Showing forgiveness to someone who broke a favorite possession.

Not at all frequently 1 2 3 4 5 6 7 8 9 Very frequently

2. Thanking family members for something they have done.

Not at all frequently 1 2 3 4 5 6 7 8 9 Very frequently

3. Exclaiming over a beautiful day.

Not at all frequently 1 2 3 4 5 6 7 8 9 Very frequently

4. Showing contempt for another's actions.

Not at all frequently 1 2 3 4 5 6 7 8 9 Very frequent

5. Expressing dissatisfaction with someone else's behavior.

Not at all frequently 1 2 3 4 5 6 7 8 9 Very frequently

6. Praising someone for good work.

Not at all frequently 1 2 3 4 5 6 7 8 9 Very frequently

7. Expressing anger at someone else's carelessness.

Not at all frequently 1 2 3 4 5 6 7 8 9 Very frequently

8. Sulking over unfair treatment by a family member.

Not at all frequently 1 2 3 4 5 6 7 8 9 Very frequently

9. Blaming one another for family troubles.

Not at all frequently 1 2 3 4 5 6 7 8 9 Very frequently

10. Crying after an unpleasant disagreement.

Not at all frequently 1 2 3 4 5 6 7 8 9 Very frequently

11. Putting down other people's interests.

Not at all frequently 1 2 3 4 5 6 7 8 9 Very frequently

12. Showing dislike for someone.

Not at all frequently 1 2 3 4 5 6 7 8 9 Very frequently

13. Seeking approval for an action.

Not at all frequently 1 2 3 4 5 6 7 8 9 Very frequently

14. Expressing embarrassment over stupid mistakes.

Not at all frequently 1 2 3 4 5 6 7 8 9 Very frequently

15. Going to pieces when tension builds up.

Not at all frequently 1 2 3 4 5 6 7 8 9 Very frequently

16. Expressing exhilaration after an unexpected triumph.

Not at all frequently 1 2 3 4 5 6 7 8 9 Very frequently

17. Expressing excitement over one's future plans.

Not at all frequently 1 2 3 4 5 6 7 8 9 Very frequently

18. Demonstrating admiration.

Not at all frequently 1 2 3 4 5 6 7 8 9 Very frequently

19. Expressing sorrow when a pet dies.

Not at all frequently 1 2 3 4 5 6 7 8 9 Very frequently

20. Expressing disappointment over something that didn't work out.

Not at all frequently 1 2 3 4 5 6 7 8 9 Very frequently

21. Telling someone how nice they look.

Not at all frequently 1 2 3 4 5 6 7 8 9 Very frequently

22. Expressing sympathy for someone's troubles.

Not at all frequently 1 2 3 4 5 6 7 8 9 Very frequently

23. Expressing deep affection or love for someone.

Not at all frequently 1 2 3 4 5 6 7 8 9 Very frequently

24. Quarreling with a family member.

Not at all frequently 1 2 3 4 5 6 7 8 9 Very frequently

25. Crying when someone leaves.

Not at all frequently 1 2 3 4 5 6 7 8 9 Very frequently

26. Spontaneously hugging a family member.

Not at all frequently 1 2 3 4 5 6 7 8 9 Very frequently

27. Expressing momentary anger over a trivial irritation.

Not at all frequently 1 2 3 4 5 6 7 8 9 Very frequently

28. Expressing concern for the success of other family members.

Not at all frequently 1 2 3 4 5 6 7 8 9 Very frequently

29. Apologizing for being late.

Not at all frequently 1 2 3 4 5 6 7 8 9 Very frequently

30. Offering to do somebody a favor.

Not at all frequently 1 2 3 4 5 6 7 8 9 Very frequently

31. Snuggling up to a family member.

Not at all frequently 1 2 3 4 5 6 7 8 9 Very frequently

32. Crying for being punished.

Not at all frequently 1 2 3 4 5 6 7 8 9 Very frequently

33. Trying to cheer up someone who is sad.

Not at all frequently 1 2 3 4 5 6 7 8 9 Very frequently

34. Telling family members how hurt you are.

Not at all frequently 1 2 3 4 5 6 7 8 9 Very frequently

35. Telling family members how happy you are.

Not at all frequently 1 2 3 4 5 6 7 8 9 Very frequently

36. Threatening someone.

Not at all frequently 1 2 3 4 5 6 7 8 9 Very frequently

37. Criticizing someone for being late.

Not at all frequently 1 2 3 4 5 6 7 8 9 Very frequently

38. Expressing gratitude for a favor.

Not at all frequently 1 2 3 4 5 6 7 8 9 Very frequently

39. Surprising someone with a little gift or favor.

Not at all frequently 1 2 3 4 5 6 7 8 9 Very frequently

40. Saying "I'm sorry" when one realizes one was wrong.

Not at all frequently 1 2 3 4 5 6 7 8 9 Very frequently

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