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Combating Stress with Yoga: A Theoretical Model of Self-Regulation

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Combating Stress with Yoga: A Theoretical Model of Self-Regulation

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Abstract

Exposure to environmental stressors may challenge children's developing self-regulatory abilities and increase their risk of developing emotional and behavior problems. Interventions aimed at improving children's self-regulatory skills, specifically emotion regulation and attentional control, may reduce children's risk for adjustment problems. The present study proposed a novel theoretical model which describes how participation in yoga may increase children's self-regulatory skills and increase children's mindfulness, or the ability to focus attention on the present moment. Both self-regulation and mindfulness were expected to be associated with fewer anxiety problems. Components of the theoretical model were evaluated using a very small sample of at-risk, elementary-aged children who participated in a school-based yoga program. Consistent with expectations, emotion regulation was statistically and significantly associated with better mindfulness and less anxiety; attentional control was associated with fewer anxiety problems. Contrary to expectations, attentional control was unrelated to mindfulness. Moreover, mindfulness did not interact with either attentional control or emotion regulation to predict anxiety. Results are discussed in terms of theoretical implications and critical next steps needed to evaluate yoga as a potential tool for reducing children's risk for problem behavior by way of strengthening self-regulatory mechanisms.

Keywords: contextual stressors, yoga, self-regulation, mindfulness, anxiety

Overview

Self-regulation is a broad term that includes regulating physiological stress response, focusing and maintaining attention (Blair & Raver, 2014), inhibiting dominant responses, as well as maintaining behavioral and emotional control (Rueda, Posner, & Rothbart, 2005). The development of self-regulation in childhood is critical for academic and behavioral success in school (Diamond, 2010; Flook et al., 2010; Greenberg et al., 2003; Mendelson et al., 2013). Improvements in childhood self-regulation are related to fewer behavior problems, improved executive functions, and academic skills (Raver, Jones, Li-Grinning, Zia, Bub, & Pressler, 2011).

Children raised in poverty are at an increased risk for developing problems with self-regulation. In fact, more exposure to poverty-related risk factors has been found to predict more difficulties with self-regulation (e.g., Roy & Raver, 2014). In turn, poor self-regulation skills are associated with more symptoms of psychopathology (Scott & Weems, 2014; Snyder et al., 2009; Zahn-Waxler, Dougan, & Slattery, 2000). Children raised in the poorest neighborhoods are three times more likely to suffer from mental health problems than children from financially well-off households (Murali & Oyebode, 2004). Moreover, children raised in poverty are more likely to experience mental health problems than adolescents raised in poverty (Murali & Oyebode, 2004) and children raised in poverty are less likely to receive mental health services than adolescents raised in poverty (Merikangas, He, Brody, Fisher, Bourdon, & Kortex, 2010).

Not all children exposed to multiple stressors develop mental health problems. In fact, adaptive self-regulation can buffer children from the negative impact of exposure to stressors on overall adjustment (Leguna, 2002; Troy & Mauss, 2011). For decades, evidence-based interventions implemented in school settings have focused on improving self-regulation by teaching children self-regulatory skills (Weissberg, Durlak, Domitrovich, & Gullotta, 2015).

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Two limitations with these programs are worth mentioning. First, self-regulation training programs are hard to integrate into the school curriculum (Greenberg et al., 2003). Second, self-regulation programs often rely heavily on teaching children explicit social and emotional skills (e.g., sharing, problem solving, and empathy) through cognitive education approaches (e.g., weekly discussion topics, homework, or brain games) and then provide opportunities to practice learned skills (Butzer et al., 2016; CASEL, 2013). In contrast, yoga is emerging as a promising new approach to enhance children's self-regulation within a school setting and can be easily integrated into physical education classes.

Yoga enhances self-regulation by improving autonomic and attentional regulatory processes rather than relying on response-focused coping skills (Gard et al., 2014). In yoga, children practice effortful regulation through deep breathing, focused attention on an internal experience or external focal point, and physically demanding postures (Butzer et al., 2015). Each of these three yoga components may improve self-regulation. For instance, deep breathing is related to autonomic functioning, by enhancing activity of the parasympathetic nervous system and has a calming effect on the sympathetic nervous system (Brown & Gerbard, 2005; Streeter et al., 2012). Similarly, children who are able to shift and focus attention also have been found to have better attentional control in the classroom (Blair & Raver, 2014). Finally, the complexity of the physical yoga postures requires deep breathing and focused, attentional control (Mendelson, Greenberg, Dariotis, Gould, Rhodes, & Leaf, 2010).

In addition to strengthening autonomic and attentional regulatory processes, yoga may cultivate mindfulness (Butzer et al., 2016). While mindfulness has been conceptualized in many different ways, the common themes that emerge are: present-moment awareness, focused attention, and nonjudgmental acceptance of thoughts, emotions, and arousal states (Black, 2011;

Brown, Ryan, & Creswell, 2007; Kabat-Zinn, 2003; Rahl, Lindsay, Pacilio, & Brown, 2016; Teper, Segal, & Izlich, 2013). Teaching mindfulness to children has a number of advantages. Mindfulness teaches children to: 1) attend to their thoughts, emotions and arousal states, 2) to accept thoughts as transient responses to events (Brown et al., 2007; Teper et al., 2013; Williams, 2010), and 3) to prevent engaging in prolonged cognitive, emotional, and behavioral responses that are often maladaptive (e.g., rumination, avoidance; Williams, 2010). Additionally, when children become more aware of their thoughts, emotions, and arousal states, they may begin to use response-focused coping skills learned in yoga (e.g., deep breathing, shifting attention) to settle arousing thoughts and feelings (Butzer et al., 2016). Importantly, the core mindfulness skills are commonly found in many cognitive behavioral interventions (e.g., Acceptance and Commitment Therapy; Coyne, McHugh, & Martinez, 2011). Although yoga is considered an innovative approach to optimize self-regulatory skills, very little work has considered if and how the regular practice of yoga would benefit children, particularly children exposed contextual stressors (Mendelson et al., 2010; Roeser & Zelazo, 2012). Importantly, little is known regarding how mindfulness develops or how mindfulness can be cultivated in children, an area in need of theoretical and empirical consideration (Roeser & Zelazo, 2012).

The present study is based on a fundamental assumption that increased exposure to contextual stressors will undermine children's ability to self-regulate (see path a, Figure 1) and poor self-regulation will be linked to more behavior problems in general and anxiety problems in particular (see path b, Figure 1). The following discussion will focus on how exposure to contextual stressors will indirectly influence children's anxiety problems by way of disrupting the development of self-regulation. Yoga is hypothesized to be a mechanism that may disrupt the impact of stressors on children's ability to self-regulate (see path c, Figure 1) as well as a way for

children to use of self-regulation skills to manage their anxiety (see paths d and b, Figure 1). The following review will first describe research linking contextual stress, self-regulation, and anxiety. Next, a novel theoretical model is proposed to explain how, at a biological level, yoga may influence self-regulatory abilities. Additionally, empirical questions concerning the utility of mindfulness in childhood are discussed. Finally, using previously collected data from a sample of low-income elementary school students who participated in school-based yoga classes, preliminary hypotheses derived from the model will be evaluated.

Enhancing Self-Regulation through Yoga: A Psychobiological Approach

Stress can interfere with the ability to develop effective self-regulation skills in childhood (Blair & Raver, 2014). Stress refers to environmental or psychological events that threaten physical and psychological well-being (Grant et al., 2003). The term stressor refers to the actual threatening event (Grant et al., 2003). Environmental stressors pose a threat to physical safety (Grant et al., 2003). Psychological stressors are anticipated or perceived threat, such as worrisome or fearful thoughts, and occur regardless of whether a physical threat exists (Cohen, Janicki-Deverts, & Miller, 2007). Stressors can be positive or negative and can be either acute or chronic (Porges, 2009; Schneiderman et al., 2005). Perceiving a stressor as controllable results in feelings of competence, control and resiliency (McEwen & Gianaros, 2011). Perceiving a stressor as uncontrollable may degrade physiological response to stressors over time (McEwen & Gianaros, 2011). Acute stressors are relatively brief and include life events such as public speaking, witnessing a violent event, or going through a divorce (Steptoe & Hamer, 2006). Acute stressors can become chronic stressors when stressors occur on a regular basis or when acute stressors accumulate over time (McEwen, 1998; Steptoe & Hamer, 2006). Even the anticipation of acute stressors can result in chronic stress (McEwen, 1998). For example, witnessing one

episode of domestic violence is an acute stressor. If the violence continues or if lasting intrusive and worrisome thoughts associated with the abuse emerge, then the events are chronic stressors.

Exposure to chronic stressors is more likely to occur among families living in poverty because impoverished families often experience acute stressors and have limited resources to cope with the stressors (Murali & Oyebode, 2004). Children of parents who lack financial resources tend to live in overcrowded houses in dangerous and noisy neighborhoods, are exposed to interpersonal conflict, have poor nutrition, and experience barriers to quality education, healthcare, and social support systems (McLoyd, 1998). Children's exposure to chronically stressful conditions can compromise self-regulatory systems which interferes with the capacity to respond adaptively to acute stressors. Repeated exposure to acute stressors and chronic stress exposure increases children's risk for developing psychosocial problems (Blair, 2010; Blair & Raver, 2011; McLoyd, 1998; Luecken, Applehans, Kraft, & Brown, 2006) and may help explain the increased risk of mental health problems for children living in poverty (McLoyd, 1998). As depicted in Figure 1, one way stressors negatively impact self-regulation is through repeated activation of the physiological stress response system (see path a, Figure 1; Del Guidice et al., 2014).

Self-regulation systems in response to contextual stressors.

Self-regulation is an umbrella term used to encompass the ability to control many different systems (e.g., attentional, behavioral, and physiological) to adapt to the changing demands of the environment (Blair & Raver, 2014; Kochanska, Coy, & Murray, 2001). The parasympathetic nervous system and the executive attention network are implicated in efforts to regulate emotional reactivity (Blair & Raver, 2011, 2014; Calkins, Dedmon, Gill, Lomax, & Johnson, 2002; El-Sheikh & Erath, 2011; Loman & Gunnar, 2010; Porges, Doussard-Roosevelt,

& Maiti, 1984; Santucci et al., 2008) through modulating the intensity and/or duration of physiological reactivity (Troy & Mauss, 2011).

Parasympathetic nervous system functioning in response to contextual stressors.

The vagus nerve is the primary nerve of the parasympathetic nervous systems (PNS) and innervates the heart and lungs. The vagus nerve controls which system is active to manage individual responses to stressors by acting like a "brake" to regulate heart rate in response to environmental demands (Porges, 2007). Three distinct yet related systems can respond to stressors, depending on the action of the vagus nerve (Del Guidice et al., 2014). The first two systems are part of the autonomic nervous system and include the parasympathetic branch (PNS) and the sympathetic branch (SNS). The PNS and SNS work in opposition to one another, such that the activation of one system suppresses the activation of the other system. The third system is the hypothalamic-pituitary-adrenal (HPA) axis (Del Guidice et al., 2014). When the vagal brake is engaged (i.e., applied to the heart), the body operates under parasympathetic control. In this restful state, arousal and heart rate are low, respiration is slow, and the body is able to efficiently regulate internal organs to promote growth and restoration and dampens the negative effects of stress on the body (Del Guidice et al., 2011; Porges, 2007, 2009).

Upon withdrawal of the vagal brake, the SNS and/or HPA axis activate, depending on the nature, duration, and intensity of the stressor (Del Guidice et al., 2014). When exposed to acute stressors, like a situation threatening survival, the vagal brake is withdrawn to activate the fast-acting SNS and deactivate the PNS. Activation of the SNS engages the body's 'fight or flight' response to mobilize the body for action and signals the adrenal glands to rapidly release epinephrine and norepinephrine (Del Guidice et al., 2011). The release of epinephrine and norepinephrine causes certain organs to quickly increase activity while simultaneously causing

other organs to decrease activity. For example, heart rate, respiration, and blood pressure accelerate in response to the release of epinephrine and norepinephrine, while the digestive system and the reproductive system decelerate to conserve resources (Porges, 2009; Shneiderman, et al., 2005). Once the stressor ends, the vagal brake is reapplied and homeostasis is regained through increased parasympathetic activation (McEwen, 1998). For example, when an individual is casually walking on the sidewalk the vagal brake is applied, or engaged, inhibiting heart rate activity and maintaining a calm, restful state. Crossing a street at an intersection and perceiving a car running a red light (i.e., a perceived stressor) would withdraw the vagal brake, allowing the SNS to respond and quickly avoid the danger. After the car has safely driven by (i.e., stressor is no longer present), the vagal brake re-engages to return the individual to a calm state (i.e., homeostasis). Such optimal functioning of the ANS is necessary for individuals to be able to respond quickly and efficiently to perceived acute stressors within an environment.

In the face of frequent anticipation of certain stressors and/or repeated exposure to perceived stressors, the SNS is unable to manage the response to stressors and the HPA axis is recruited (Miller, Chen, & Zhou, 2007). Specifically, the HPA axis activates in response to perceived social and evaluative threat, unpredictable and/or uncontrollable situations, family conflict, separation, and rejection (Del Guidice et al., 2014). Public speaking, being bullied, witnessing interpersonal conflict, and experiencing unstable housing are examples of events related to HPA axis activation (Del Guidice et al., 2014). When the HPA axis is activated, hormones such corticotropin releasing hormones (CRH), adrenocorticotropic hormones (ACTH), and eventually glucocorticoids (e.g., cortisol) are released into the bloodstream. When activated, the slow release of cortisol serves to repair damage from prolonged SNS activation and mobilize

the body's response to stressors by increasing alertness, vigilance, and the release of energy. When the vagal brake is reapplied once the stressor is no longer a threat, the body can regain homeostasis through application of the vagal brake (McEwen, 1998).

Optimally, the activities of the PNS provide organisms with energy and resources to cope with stressors. Children raised in low to moderately stressful environments primarily operate under PNS control (Del Guidice et al., 2011), which corresponds to high resting vagal tone, low resting heart rate, adaptive vagal withdrawal in the presence of stressors, and efficient vagal recovery following stressors (El-Sheikh & Erath, 2011). More research is needed linking physiological and behavioral indices of emotion regulation (El-Sheikh & Erath, 2011). However, in general, operating primarily under PNS control in low to moderately stressful environments is linked to the development of more adaptive emotion regulation and is a protective factor in the context of family conflict (El-Sheikh & Erath, 2011; Park & Thayer, 2014; Porges, 2007). For example, in a prospective study by Gottman and Katz (2008), young children's basal vagal tone, vagal withdrawal, and recovery following exposure to a stressor predicted parents' need to help their children regulate their emotions in a sample of primarily Caucasian, middle-class and educated families. Children ages 4 to 5 years with high resting vagal tone and who reacted to a parent-child stressor (e.g., parent criticism) recovered faster compared to children with low resting vagal tone. The children with high resting vagal tone were better able to independently regulate their emotions four years later than children with low resting vagal tone who relied more on parents to facilitate down-regulation of their emotions (Gottman & Katz, 2008). Children who operate primarily under PNS control have sufficient resources to meet the demands of infrequent stressors and recover quickly preventing any prolonged wear and tear on the body (El-Sheikh & Erath, 2011; Gottman & Katz, 2008).

Chronic exposure to stressors taxes the vagal system through frequent withdrawal and application of the vagus nerve on the heart. Under these conditions, the SNS and HPA axis may be over-activated and efforts to downregulate activity and regain PNS control and stability of internal organs are strained (McEwen, 1998). Allostatic load is defined as the prolonged wear and tear on the body which occurs from exposure to chronic stressors. The cost of allostatic load is poor efficiency in responding to stressors and shifting activation set-points to a dysregulated state (i.e., overactive or underactive) in response to environmental and psychological pressures (Del Guidice et al., 2011; McEwen, 1998; Shneiderman, et al., 2005). Regardless of which direction set-points have shifted, the system becomes less flexible to regulate emotional reactivity in response to stressors (Blair & Raver, 2011). This dysregulated state is reflected in low resting vagal tone, ineffective vagal withdrawal, poor recovery following stressors, and poor emotion regulation (Blair, 2010; Blair & Raver, 2011; Blair & Raver, 2014; Del Guidice et al., 2011; Porges, 2007).

When set-points of the SNS and HPA axis are shifted up and PSN down, children primarily operate under SNS control with heightened HPA activity (Del Guidice et al., 2014; El-Sheikh & Erath, 2011). Children operating under more SNS control are increasingly more attentive to environmental threats, react quickly and intensely to environmental stressors, have elevated and prolonged release of cortisol, and recover more slowly after a stressful event than children without chronic stress activation (Del Guidice et al., 2014; El-Sheikh & Erath, 2011). Operating in this constant state of vigilance to threat damages the development of systems that underlie emotion regulation reducing the ability for children to regulate emotional reactivity (El-Sheikh & Erath, 2011). When set-points of the PNS, SNS, and HPA axis are shifted down, more typical of children raised in the most stressful environments, responses to stressors are blunted,

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with low reactivity and low levels of cortisol released from the HPA axis (Del Guidice et al., 2014). When the vagus nerve is inflexible in response to the demands of the environment, the vagus nerve is unable to properly regulate reactivity in the presence of emotionally salient stimuli, and is unable to facilitate a rapid recover after the threat has passed, which exacerbates allostatic load (Del Guidice et al., 2014; El-Sheikh & Erath, 2011). While these strategies may have adapted over time to keep individuals alive in the short-term, they are related to a myriad of physical and psychological health problems (see path b, Figure 1; Del Guidice et al., 2014).

Attentional control functioning in response to contextual stressors.

Attention, specifically, focusing and shifting attention, is a component of self-regulation that modulates reactivity to emotionally salient stimuli (Blair & Raver, 2011, 2014; Loman & Gunnar, 2010). The executive attention system, located in the prefrontal cortex (PFC), differs from other attention networks (i.e., orienting and alerting) because the executive attention system can be controlled through voluntary actions (Rueda et al., 2005). The executive attention system functions to control the focus of attention and regulate reactivity to emotionally salient stimuli (Diamond and Lee, 2011; Flook et al., 2010; Gioia, Isquith, Guy, & Kenworth, 2000; Tang et al., 2012). The ability to control attention develops in early childhood, and by approximately age 7, children's executive attention system operates similarly to adult systems (Rueda et al., 2005). Optimally, attending to relevant stimuli and disregarding irrelevant or distracting information in the environment is related to sustained engagement in learning (e.g., paying attention, following directions) and successful social and emotional development (Blair & Raver, 2014). For example, adolescents without a history of abuse or parental divorce were better able to avoid (not attend to) threatening or emotionally negative words during a computer task than children with a trauma history (Lueken & Appelhans, 2005). In fact, the ability to control the focus of attention

away from emotionally salient stimuli protects against the development of internalizing and externalizing behavior problems (Lueken & Appelhans, 2005).

In the presence of an acute stressor, attention is heightened and directed towards the threat to facilitate an adaptive physiological response to stress (e.g., SNS and/or HPA axis response). After the stressor has passed, attention can be disengaged from the threat (Ellenbogen, Schwartzman, Stewart, & Walker, 2002). Take, for example, the situation in which a boy is kicking a soccer ball in the park with his father. The boy enjoys kicking the ball with his father until he notices a group of bullies from school who are looking at him. Even though he has never been bullied, his attention remains focused on the bullies (i.e., a perceived stressor) and he moves closer to his father. After the bullies leave the park (i.e., stressor is no longer present), he easily disengages his attention from the bullies and resumes passing the soccer ball with his father. Such optimal functioning of the attention network is necessary for individuals to be able to respond quickly and efficiently to perceived acute stressors within an environment.

Exposure to chronic stressors taxes the attention networks by degrading the PFC, reducing the ability to control attention and regulate reactivity (Blair & Raver, 2011, 2014; Liston, McEwen, & Casey, 2009; Loman & Gunnar, 2010). In this situation, the boy kicking the soccer ball with his father may perceive all boys as potential bullies, including the bullies he recognizes from school, and his attention becomes divided such that he cannot kick the soccer ball with his father. Impaired attentional control is related to heightened attention to negative stimuli and threatening stimuli, especially social and evaluative threat and an increased likelihood to interpret ambiguous stimuli as threatening (Crick & Dodge, 1994). Furthermore, impaired attentional control is related to disengage attention from emotionally salient stimuli (Ellenbogen et al., 2002). These attentional biases are related to the development of

psychopathology (see path b, Figure 1; Zahn-Waxler, Klimes-Dougan, Slattery, & NIMH, 2000).

For example, college students with self-reported symptoms of depression were slower to disengage their attention from the stressors (i.e., negatively worded items) and showed elevated cortisol following the stressors during an attention task than students without depressive symptoms (Ellenbogen et al., 2002). Additionally, individuals with elevated symptoms of anxiety are more likely to focus attention on past or future events perceived as threatening or negative (Zahn-Waxler et al., 2000). Understanding the deleterious effects of exposure to chronic stressors on attentional control helps explain why children reared in impoverished environments have difficulty regulating attention to modulate reactivity (Blair & Raver, 2014)).

Anxiety in response to compromised self-regulation systems.

In general, anxiety is an emotional response to avoid danger (Beesodo et al., 2009). Unlike fear, which is the response to a specific and immediate threat, anxiety occurs in the presence of a perceived or non-specific threat (Beesodo et al., 2009; Cisler, Olatunji, Felder, & Forsyth, 2010). Under many circumstances, anxiety is adaptive for survival. For instance, anxiety associated with receiving attention of bullies from school is adaptive. However, when this typical anxiety response becomes dysregulated (Weems, 2008), anxiety can interfere with emotion regulation and can impair the ability to function adaptively (Beesodo et al., 2009; Cisler et al., 2010). In childhood, anxiety is the most common internalizing behavior problems. As children mature, anxiety symptoms become more differentiated (Weems, 2008). However, the core features underlying all anxiety disorders are problems controlling thoughts and emotions and primarily expressed through behavioral (e.g., avoidance), cognitive (e.g., worry), physiological (increased heart rate) and social (e.g., interpersonal problems) dysregulation (see path b, Figure 1; Weems, 2008). If severe anxiety is not addressed during childhood, these

symptoms can persist into adulthood and can precipitate other mental health problems, especially depression and substance abuse disorders (Beesodo et al., 2009; In-Albon & Schneider, 2007). One way to address childhood anxiety is by improving self-regulation skills to help children control their thoughts and emotions (Cisler et al., 2010).

Children with compromised self-regulation systems and who suffer from anxiety typically have difficulty controlling negative emotions and adapting to environmental demands (see path b, Figure 1; Cisler et al., 2010; Snyder et al., 2009; Weems, 2008; Zahn-Waxler, Dougan, & Slattery, 2000). In fact, children who suffer from anxiety self-report problems regulating emotions (Bender, Reinholdt-Dunne, Esbjorn, & Pons, 2012) and often experience physiological symptoms of emotion dysregulation (e.g., reduced heart rate variability, increased parasympathetic withdrawal, and delayed habituation to and recovery following anxiety-provoking stimuli; Bloom, Ollson, Serlachius, Ericson, & Ingvar, 2010; Boyce, Quas, Alkon, Smider, Essex, & Kupfer, 2001; Quas et al., 2001; Zahn-Waxler, et al., 2000). Children with anxiety problems tend to experience elevated baseline levels of cortisol and greater cortisol reactivity in socially challenging situations compared to children without internalizing problems (Granger, Weisz, & Danika, 1994; Kagan, Reznick, & Snidman, 1987; Zahn-Waxler, et al., 2000).

In addition to problems with emotion regulation, children suffering from anxiety have problems with attentional control (see path b, Figure 1). Children with anxiety problems both interpret neutral or ambiguous stimuli as threatening and demonstrate a biased attention towards threatening stimuli more than asymptomatic children, even when the perceived threat is mild (Snyder et al., 2009; Zahn-Waxler, et al., 2000). This heightened attention to threatening stimuli occurs both at preconscious and conscious levels of processing in children with clinical and

subclinical levels of anxiety (Bar-Haim et al., 2007). Interestingly, clinically anxious children showed significantly more conscious attentional bias towards threat than subclinical participants (Bar-Haim et al., 2007). The difference in attentional bias between clinically and sub-clinically anxious children was not present for pre-conscious threat bias, indicating that the conscious control of attention may be one difference between clinically significant anxiety and subclinical levels of anxiety.

Taken together, anxiety problems are due in part to problems with autonomic functioning and attentional control. Children with anxiety problems tend to focus more attention on emotionally-salient stimuli and perceive neural situations as threatening. In addition, anxious children have more problems regulating increases in negative emotions and take longer to recover from negative emotions (Bar-Haim et al., 2007; Weems, 2008, Zahn-Waxler, et al., 2002). Engaging in activities, such as yoga, may benefit children with anxiety problems because yoga seeks to: 1) improve autonomic functioning by increasing PNS control and 2) engage the executive attentional network to increase attentional control (see path d, Figure 1). Repeated yoga practice may reduce the potentially harmful effects of exposure to chronic stressors on anxiety problems by increasing self-regulatory processes (see paths c and b, Figure 1; Kayley-Isley et al., 2010; Rueda et al., 2000).

Yoga as a mechanism for enhancing self-regulation.

The practice of yoga may directly influence self-regulatory behaviors (see path d, Figure 1). Yoga consists of a sequence of physical postures synched with breathing exercises (i.e., pranayama) and relaxation techniques (Butzer et al., 2015). During a sequence of physically demanding postures, yoga students are instructed to focus attention to the present moment, and be aware of and to attend to –without judgment –internal and external experiences. Students are

reminded to notice when attention is lost to mind-wandering, and shift attention back to the present (Gard et al., 2014; Hasenkamp & Barsalou, 2012; Lutz et al., 2008). Challenging physical postures demand focused attention and deep breathing to move successfully through postures; importantly, challenging postures also capitalize on children's propensity to be active (Mendelson et al., 2010). Lastly, incorporated into yoga practices are lessons in mindfulness (Kabat-Zinn, 2003; Mendelson et al., 2010).

Repeated practicing of deep diaphragmatic breathing and attentional control is expected to generalize to parasympathetic and attentional control outside of the yoga class even among children. The next section will describe how engagement in deep breathing and focused attention may improve two aspects of self-regulation, namely parasympathetic control and attentional control (see path d, Figure 1). The impact of exposure to contextual stressors on the development of anxiety problems among children is expected to be substantially reduced among children who engage in yoga because yoga should improve children's self-regulation (see paths c and b, Figure 1). Repeated engagement in yoga may have the added benefit of increasing mindfulness (see path f, Figure 1; Brown et al., 2007; Butzer et al., 2016). Because attention is a core component of mindfulness, mindfulness skills may benefit from improvements in attentional control (see path e, Figure 1; Black, 2011; Brown et al., 2007; Butzer et al., 2016; Teper, Segal, & Inzlicht, 2013). Lastly, cultivated mindfulness is expected to become a tool to reduce symptoms of anxiety (see paths g and h, Figure 1).

Breathing improves self-regulation.

Breathing is the only activity of the autonomic nervous system that can be easily controlled voluntarily (Brown & Gerbarg, 2005; Streeter et al., 2012). Pranayama breathing is a distinct style of breath regulation used in yoga that consists of slow and deep controlled

diaphragmatic breathing through the nose (Brown & Gerber, 2005; Gard et al., 2014). This style of yoga breathing enhances parasympathetic activity, indices of vagal tone (Brown & Gerbard, 2005) and changes in emotional states (Streeter et al., 2012). The specific mechanisms for how this occurs is largely theoretical (Brown & Gerbard, 2005) and a detailed neurophysiologic description is beyond the scope of this review. However, briefly stated, the vagus nerve relays information about the depth, rate, and pattern of breathing from receptors in the lungs (e.g., baroreceptors and chemoreceptors) to the vagal nucleus in the brainstem to regulate autonomic functioning (Brown & Gerbarg, 2005).

The heart and lungs are inextricably linked via the vagus nerve such that changes in one organ results in changes in the other organ (Streeter et al., 2012). In fact, heart rate naturally increases on inhalation and decreases on exhalation (Brown & Gerbarg, 2005; Porges, 2007). Respiratory sinus arythmia (RSA) measures the influence of the vagus nerve on heart rate, taking into account the natural changes in heart rate due to the respiration cycle (Brown & Gerbarg, 2005; Porges, 2007). Slow yoga breathing exaggerates the normal RSA pattern and increases parasympathetic control of the heart, creating a calm but alert state, where breath rate and heart rate are low and vagal tone is high (Brown & Gerbarg, 2005). With practice, individuals may spend more time under parasympathetic control which enhances the ability to adapt to environmental demands and recover more efficiently after exposure to stressors (Brown & Gerbarg, 2005; Streeter et al., 2012). This may be especially impactful for children exposed to chronic stressors, because more time under parasympathetic control allows for physiological repairs to allostatic damage and re-balancing of the ANS and HPA axis (Del Guidice et al., 2014; McEwen, 1998).

Attentional control improves self-regulation.

As compared to breathing exercises, comparatively less is known regarding how yoga enhances attentional control, especially among children (Felver et al., 2014). Yoga involves engaging and disengaging attention from external and internal distractions to selectively attend to important stimuli (Gard et al., 2014). Importantly, willful attentional control is a critical component of self-regulation during childhood (Eisenberg et al., 2004; Lutz et al., 2008). Practicing attentional control within the context of yoga may enhance attentional control in other contexts and settings, perhaps because the act of focusing attention creates new neural pathways which support attentional focusing (Gard et al., 2014; Hasenkamp & Barsalou, 2012). This may be especially impactful for children exposed to chronic stressors, because chronic stressors degrade the underlying neural mechanism of attentional control (Blair & Raver, 2011, 2014; Liston, McEwen, & Casey, 2009; Loman & Gunnar, 2010).

Mindfulness cultivated through attentional control.

There is growing empirical support for the cognitive and physical health benefits of clinical interventions that infuse cognitive-behavioral therapy with mindfulness among children and adolescents, such as mindfulness-based stress reduction (MBSR; Bennett & Dorjee, 2015), acceptance and commitment therapy (ACT; Coyne et al., 2011), and mindfulness-based cognitive therapy (MBCT; Lee, Semple, Rosa, & Miller, 2008; Semple, Lee, Rosa, & Miller, 2009). While both clinical interventions and yoga teach mindfulness, little is known about how mindfulness is cultivated among children participating in school-based yoga programs (Brown et al., 2007; Roeser & Zelazo, 2012). Mindfulness develops in a variety of activities and lacks consistency in definition, operationalization, and measurement, all which limit the ability to generalize the benefits from one method of practicing mindfulness to another (Brown et al.,

2007). A more informed developmental understanding of the essential elements of mindfulness and how mindfulness emerges through children's yoga is needed in order to advance the science of mindfulness (Brown et al., 2007; Roeser & Zelazo, 2012).

Cultivating mindfulness likely begins when children can learn to focus and control their attention (see path e, Figure 1). Teaching children to pay attention to thoughts, emotions, and arousal states that enter their awareness increases their awareness of distressing thoughts and feelings (e.g., thoughts of failure; Baer, 2003; Brown, et al., 2007; Butzer et al., 2016; Teper et al., 2013). Additionally, children must be taught to accept these distressing thoughts, emotions, and arousal states as automatic response to events that are transient and will pass (Teper et al., 2013). According to Teper and colleagues (2013), accepting thoughts, emotions, and arousal states with a non-value laden attitude is a critical step in decreasing overlearned maladaptive responses (e.g., ruminating on or suppressing negative thoughts). Accepting distressing experiences does not eliminate the initial distressing response. Instead, acceptance aims to prevent elaboration (e.g., rumination) or avoidance of the initial distress (Baer, 2003; Hozel et al., 2011b; Teper et al., 2013; Williams, 2010).

How mindfulness may prevent maladaptive physiological and emotional responses is still largely theoretical (see Hozel et al., 2011b; Vago & Silbersweig, 2012 for a full description). When children learn to attend to distressing thoughts, emotions, and arousal states, theoretically, they engage in a form of exposure to the distressing event (Hozel et al., 2011b; Vago & Silbersweig, 2012). That is, by attending to thoughts and emotions, children relive the distressing event. When children attend to distressing thoughts without increasing feelings of distress, then children can begin the process of de-coupling the thoughts from emotions. Such a decoupling may reduce anxiety by diminishing ruminating thoughts and emotions. With time, the

relationship between the stimulus and its previously conditioned response is extinguished, and replaced by a new and adaptive response (Baer, 2003; Hozel et al., 2011b; Vago & Silbersweig, 2012). Over time, the process of decoupling distressing emotions from distressing thoughts may create new neural pathways to replace previously ingrained responses (Baer, 2003; Butzer et al., 2016; Gard et al., 2014; Hozel et al., 2011b; Vago & Silbersweig, 2012; Teper et al., 2013). To illustrate this point, consider a child whose parents have a difficult time discussing negative emotions (e.g., fear, sadness, anger). Over time, this child learns to not express negative feelings because her parents always minimize them. Instead, she learns to keep her negative feelings inside. Through mindfulness, she may be able to accept the negative feelings that occur when something negative happens. When she is able to repeatedly do this, her previously conditioned maladaptive response of keeping her feelings inside will be extinguished and replaced with an adaptive response of accepting her negative thoughts as okay and transient.

Elementary school-aged children's capacity to accept distress nonjudgmentally remains unknown (Lawlor et al., 2013). Furthermore, empirical research is needed to demonstrate whether yoga teaches children to use response-focused coping skills (i.e., deep breathing, attention shifting) to help relieve distressing thoughts and emotions (Baer, 2003; Teper et al., 2013). In fact, a common aspect of many elementary school-based social and emotional learning interventions teach children to use this method of coping (Butzer et al., 2016; CASEL, 2013). By practicing mindfulness, children may become more aware of their distress, and consequently, may be more likely to use these response-focused coping skills to reduce arousing thoughts and feelings on their own (Baer, 2003; Butzer et al., 2016).

Empirical support for salutary benefits of yoga.

Few studies have examined the impact of yoga on physiological, emotional, cognitive, and behavioral indices of arousal and regulation with youth, especially children exposed to many poverty-related stressors. Even less is known about the contribution of mindfulness in the link between yoga and children's mental health outcomes. However, yoga is emerging as an important mechanism to enhance self-regulation. What follows is not a comprehensive review of all research, rather select studies that highlight the promising impact of yoga to improve indices of self-regulation.

Youth who practice yoga and sitting meditation with deep breathing in school show improvements in regulating indices of physiological arousal. For example, adolescents with high-average (pre-hypertensive) blood pressure had significant reductions in blood pressure and alpha-amylase (a maker of acute stress) after three months of biweekly yoga practice (Sieverdes et al., 2014). A series of studies by Barnes and colleagues examined the impact of brief sitting meditation with a focus on deep breathing, on heart rate and blood pressure in youth with high-average blood pressure. Sample characteristics and duration of the interventions varied. Overall, studies found lowered resting heart rate and blood pressure in youth who completed daily meditation compared to controls. These results were found after once daily meditation for 12 weeks in a diverse sample of male and female seventh grade students (Barnes, Davis, Murzynowski, & Treiber, 2004) and African-American ninth grade students (Barnes, Pendergrast, Harshfiled, & Treiber, 2008). Improved heart rate and blood pressure remained significant at the 3-month follow-up (Wright, Gregoski, Tingen, Barnes, & Treiber, 2011). Similar results were found in a sample of primarily African American male and female high

school students who meditated twice daily for two months (Barnes, Treiber, & Davis, 2001), four months, and after the four-month follow-up (Barnes, Treiber, & Johnson, 2004).

Studies that examine the impact of yoga on indices of arousal, regulation, and attentional control for urban elementary school students with low and moderate symptoms of depression self-reported improvements in emotional arousal, physiological arousal, rumination, and intrusive thoughts following four weekly 45-minute school-based yoga classes for 12 weeks (Gould et al., 2012; Mendelson et al., 2010). Studies specific to emotion regulation found that middle and high school students self-reported improvements in emotion regulation after participating in three weekly 40-minute school-based yoga classes for 16 weeks (Daly, Haden, Hagins, Papouchis, & Ramirez 2015). Interestingly, after just one yoga class, high school students self-reported marginally significant improvements in negative affect compared to physical education class (Felver, Butzer, Olson, Smith, & Khalsa, 2015). Studies specific to attentional control found that after participating in 13 school-based yoga classes during four months, teachers reported that children demonstrated improvements in attention span and inattention (Ehud, Bar-Dov, & Avshalom, 2010). Some studies that found improvements in attention also indicated improvements in anxiety. After elementary school students participated in twelve bimonthly mindfulness classes (e.g., pranayama breath exercise, body scans, yoga poses, discussions), each lasting 45 minutes in length, teachers reported improvements in test anxiety, attention, and students performed better on a selective attention task (Napoli, Krech, & Holley, 2005). Lastly, elementary school students who performed better on an executive function task also had teachers who reported fewer anxiety problems after four weeks of daily, 15-minute lessons focusing on mindful awareness of the body, feelings, thoughts, and relationships through mindful breathing and movements (e.g., yoga) and its real-world application. Interestingly, while

attention (inhibitory control, cognitive flexibility, and working memory) improved on an executive functioning task, teacher reported attention problems did not improve, suggesting perhaps longer interventions are required to see behavioral changes in attention (Parker, Kupersmidt, Mathis, Scull, & Sims, 2014).

The relative contribution of mindfulness in children's yoga and meditation programs is largely unknown and participants are typically in middle and high school (Baer, 2003; Felver et al., 2016; Hornett & Dawes, 2012; Thompson et al., 2009; Zenner, Hernleben-Kurz, & Walach, 2014). Using the Kripalu curriculum, high school students self-reported increases in mindfulness that approached significance, after participating in 28 bi-weekly school-based yoga classes compared to the typical physical education class (2-3 times per week; Noggle et al., 2012). Importantly, the yoga instructor was a certified adolescent yoga teacher, there was at least one assistant yoga teacher present at all times, and the average attendance rate was 58%. Additionally, students self-reported improvements in tension-anxiety, negative affect, and depression, but not positive affect, perceived stress, resilience, or anger expression.

Participating in daily meditation classes (3-12 minutes) for 6 weeks was not related to significant improvements in mindfulness for high school students. The curriculum consisted learning to attend to breathing, and label, but not focus attention on sensations, thoughts, and emotions, and body sweeps. Interesting, while no improvements in mindfulness were reported, students did self-report improvements on measures of cognitive and emotional functioning (Britton, Lepp, Niles, Rocha, Fisher, & Gold, 2014). Students who participated in a more intensive mindfulness-based social and emotional curriculum, MindUP, self-reported improvements in mindfulness. Fourth and fifth grade students participated for 12 weekly sessions (40-50 min), consisting of lessons to promote executive functions, self-regulation,

social-emotional understanding, and a positive mood. Additionally, brief 3-minute breath-focused meditations were implemented three times throughout the day. Results indicated that students who received the intervention self-reported improvements in mindfulness, empathy, perspective taking, optimism, emotional control, depressive symptoms, peer-rated prosocial behaviors, and performed significantly better on a computerized test of attention and response inhibition (Schonert-Reichl et al., 2015).

Lastly, benefits of mindfulness training may differ depending on home-life characteristics. Middle school students from a traditional charter school and from a school specific for children who have recently, or are currently, living with family in a homeless shelter, received the same manualized mindfulness training program for 8 weekly 45-minute classes. Classes consisted of mindful listening and eating, a guided breathing exercise, and weekly themes (e.g., managing difficult emotions). Students completed self-report measures of mindfulness, self-compassion, and cognitive and behavioral flexibility. Results indicated no significant improvements on any measure for either group, except for improved mindfulness for the traditional middle school students. However, reliability coefficients for the mindfulness measure were not reported. Interestingly, students currently homeless or with a recent history of homelessness "liked or loved" the mindfulness class and endorsed wanting to use mindfulness skills after the mindfulness class ended significantly more than students from the traditional school (Viafora et al., 2014).

In summary, yoga is promising new way to provide youth with tools to enhance their self-regulation and buffer some of the negative impact of exposure to contextual stressors. Yoga is related to improved physiological and behavioral indices of emotional arousal and regulation and attentional control, along with reduced psychological sequelae of dysregulation (Daly et al.,

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2015; Ehud, Bar-Dov, & Avshalom, 2010; Gould et al., 2012; Mendelson et al., 2010).

Additionally, the degree to which mindfulness-based programs enhance mindfulness is largely

unknown, and may depend on factors including the design of the intervention, participant

engagement, and the age of the participants (Britton et al., 2014; Noggle et al., 2012; Schonert-

Reichl et al., 2015; Viafora et al., 2014). The aim of the current pilot study is to test the proposed

theoretical model using data from a sample of elementary school children from a predominantly

low-income charter school. In the following section, the model will be described using anxiety as

the index of childhood adjustment problems because of the high prevalence rate in childhood

(Weems, 2008).

Goals of the Present Study

Model Application

Providing children with yoga may be an additional tool to improve attentional control and parasympathetic control (see path d, Figure 1) as well as a protective factor against the impact of contextual stressors on self-regulatory skills (see path c, Figure 1). Additionally, as the model illustrates, self-regulatory systems may be related to each other (see path i; Figure 1). Further, the regular practice of yoga may help alleviate symptoms of anxiety (see path b, Figure 1). When children first begin yoga, breathing exercises may be most beneficial; over time, the benefits of yoga should extend to increased attentional control and mindfulness (see paths e and f, Figure 1; Streeter et al., 2012). Theoretically, as children become more mindful, they also may become more aware of their feelings of anxiety (see path h, Figure 1). Yoga exercises may reduce anxious symptoms by providing children with coping behaviors, such as deep relaxing breathing, shifting attention away from perceived threat, and acceptance of feelings (see paths g and h, Figure 1).

Hypotheses

Empirically evaluating the proposed theoretical model involves testing six overarching hypotheses. Focusing specifically on symptoms of anxiety and mindfulness that includes attention and awareness, excluding nonjudgmental acceptance:

1. Exposure to more contextual stressors will be associated with poorer self-regulation and positively associated with more anxiety symptoms.

2. Better self-regulation will be correlated with fewer anxiety symptoms.

3. Yoga engagement will be associated with better self-regulation and mindfulness as well as fewer anxiety symptoms.

4. Yoga engagement will moderate the relationship between contextual stressors and self-regulation such that under conditions of low yoga engagement, exposure to more contextual stressors will be negatively correlated with self-regulation. At high levels of yoga engagement, exposure to more contextual stressors will be unrelated to self-regulation.

5. Self-regulation will partially mediate the relationship between yoga engagement and anxiety symptoms.

6. Mindfulness will partially mediate the relationship between yoga engagement and anxiety symptoms.

The present study will test four hypotheses derived from this larger theoretical model. Again, focusing specifically on symptoms of anxiety. In this evaluation, the measure of mindfulness includes awareness and nonjudgmental acceptance:

1. Self-regulatory skills will be correlated with each other; such that better emotion regulation will be positively correlated with better attentional control.

2. Self-regulatory skills, specifically emotion regulation and attentional control, will be negatively correlated with anxiety symptoms.

3. More mindfulness skills will be correlated with better self-regulatory skills, specifically emotion regulation and attentional control, and fewer anxiety symptoms.

4. Mindfulness will moderate the association between self-regulation and anxiety symptoms. Specifically, as levels of mindfulness increase, more attentional control will be associated with fewer anxiety symptoms. Similarly, as levels of mindfulness increase, better emotion regulation will be associated with fewer anxiety symptoms.
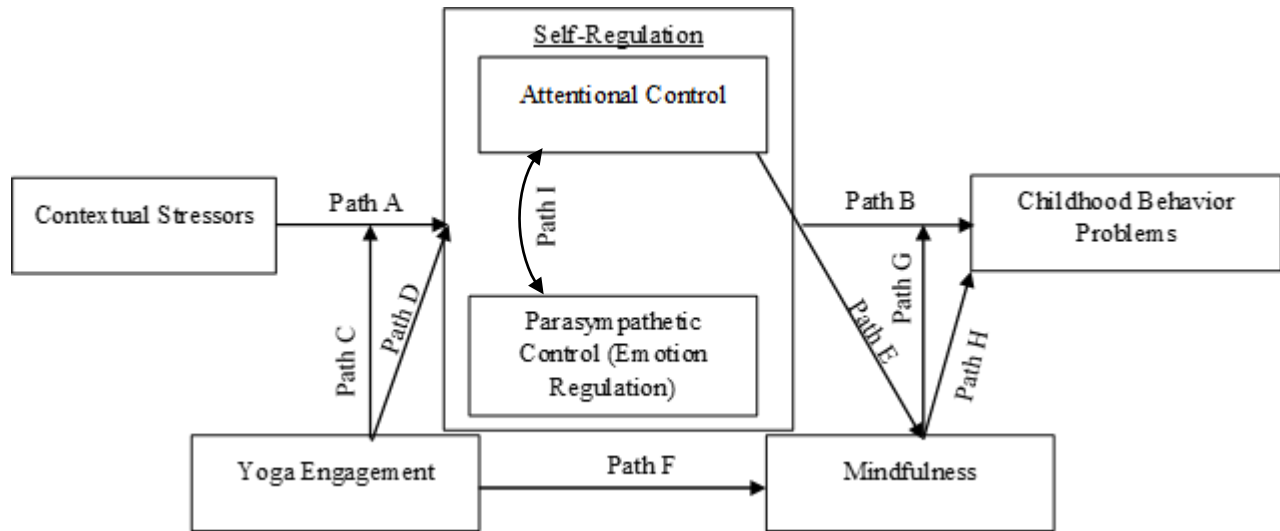
Figure 1. Theoretical model of self-regulation. Contextual stressors negatively impact parasympathetic control and attentional control (Path A). Parasympathetic control and attentional control are positively related (Path I) and both are negatively related to behavior problems (Path B). Engagement in yoga will directly improve self-regulation (Path D) and moderate the relationship between contextual stressors and self-regulation (Path C). Yoga engagement will improve mindfulness (Path F), party through the increase in attentional control (Path E). Thus, attentional control will partially mediate the relationship between yoga engagement and mindfulness (Path D and E). Mindfulness will buffer against adjustment problems (Path G and H).

Method

Participants

Participants (N = 20 parents; 20 children) were from one public charter elementary school. Students were eligible to participate if they were enrolled in yoga during the academic year. The final sample of children consisted of 13 females and 7 males, ranging in age from 6 to 12 years (mean = 8.81 years, SD = 2.02). The majority of students were in 5th grade (37.5%), with students ranging from 1st through 5th grade. Participants were primarily African-American (87.5%). Parents who completed the parent-report questionnaires were approximately 32.86 years (SD = 6.41), and 62.5% of parents earned a high school diploma or general equivalency diploma. Approximately 63% of parents were single. All parents (100%) indicated that they qualified for the assisted meal program. The majority of parents (62.5%) and under half of students (41.7%) reported no mindfulness practiced (i.e., yoga or meditation). See Table 1 for a full description of parent and child characteristics by percentage.

Procedure

All study procedures were approved by the Institutional Review Board of the researchers' affiliated institution. All students who participated in yoga were eligible for participation. This included approximately 300 children in first through sixth grades. Students attended daily yoga sessions on a rotation of three weeks of yoga followed by six weeks of other activities for the entire academic year. Participation consisted of parents, teachers, and students completing questionnaires. First, packets containing a consent form and a questionnaire were sent home with children for parents to review, sign, and complete. Once completed, parents returned the sealed packets to teachers or mailed packets directly to the principal investigator. Packets were sent home roughly three months after the first semester of yoga started. In an attempt to increase participation, parents received a second round of packets at the beginning of the second semester.

Second, after obtaining questionnaires and parental consent for their children and for their children's teachers to participate, the research team distributed a packet of questionnaires to each child. Children were read each question at school and received a small gift (e.g., key chains) with a value under $2 as a thank you for their participation. Data were collected from students over the course of two weeks, approximately one month before the end of the second semester. Third, homeroom teachers were asked to complete questionnaires using a secure online survey generator (i.e., Qualtrics). Teachers completed questionnaires after completed questionnaires from parents had been received. As compensation for parents' and teachers' time, the teachers were given gift certificates to be used for school supplies. Given the very low response rate from teachers, teacher data were not used in the current study.

Yoga Intervention. The yoga instructor was an Experienced Registered Yoga Teacher (E-RYT) and a Registered Children's Yoga Teacher (RCYT) in accordance with standards from the Yoga Alliance Registry Standards. The yoga curriculum used in this study was a version of the Yoga Ed program that aligns with national standards for physical education and implemented in schools all over the United States (http://yogaed.com).

According to the most recent review of school-based yoga programs (Khalsa et al., 2016), the Yoga Ed curriculum has two studies, one randomized controlled trial with high school student (Khalsa et al., 2012) and one non-randomized controlled study where school teachers were trained to teach yoga to their elementary and middle school students (Chen & Pawels, 2014). While the two studies used the Yoga Ed curriculum, they differed considerably in terms of duration of yoga classes (30-40 minutes vs. 5-15 minutes, respectively), frequency and duration of the program (one semester vs one year, respectively), and training experience of the yoga instructors (200-hours vs two days, respectively), making their results hard to compare. For

high school students, improvements in anger control and resilience indices were observed as compared to the physical education control group (Khalsa et al., 2012). Additionally, using qualitative analyses, results suggest improvements in joy, self-esteem, enthusiasm, confidence, knowledge of the human body, energy, interpersonal relationship, sleep, and concentration, compared to before the intervention began (Chen & Pawels, 2014). Clearly, more studies are needed to examine the benefit of using the Yoga Ed curriculum.

Yoga classes were 40 to 45 minutes in length. Each yoga class consists of a *concept*, or goal for what students should learn from the lesson, and a *theme*, which is one idea that ties all components of the yoga class together. The theme and concept are referenced throughout class and can vary from class to class. Lesson plans typically consist of seven components and reinforce the theme and concept. Lessons include seven components. First, *Time – in* (1 - 3 minutes), students begin conscious breathing aimed at focusing attention to the breath and away from distraction, and to calm the mind and body to prepare for yoga class. Second, *Discussion* (3 - 5 minutes), students learn about the concept and theme for the class through discussion, writing, reading, and sharing. Third, *Warm-up* (5 minutes), students prepare their mind and body for challenging postures. This can take a variety of forms, such as games, simple yoga postures, breathing exercises, and stories. Fourth, *Yoga postures* (15 - 20 minutes), students move through a sequence of postures that can include standing poses, balancing poses, backbends, hip openers, twists, inversions, forward folds, and restorative poses. Additionally, story telling may be used to lead students through a series of yoga postures. This method is especially engaging for younger children because it captures their imagination. Fifth, *Game or partner work* (5-10 minutes), students work collaboratively to communicate and problem solve. Sixth, *Relaxation* (3-5 minutes), students shift attention back to themselves and calm their mind and body using

different techniques (e.g., progressive muscle relaxation, conscious breathing, visualizations, etc.). Finally, C*lass project or homework* (5-15 minutes), students are encouraged to reflect on the theme and concept through creative expression.

Importantly, the manual provides many different options for teaching each component along with detailed written and visual instructions. For example, there are 13 different calming breath exercises, 15 different standing poses, and 16 different partner poses. Thus, it is up to the yoga instructor to plan each lesson to meet the specific needs of the students on any given day. What follows is a sample lesson for 4th and 5th grade students to illustrate how the concept, theme, and components can work together to facilitate self-regulation. All material below is taken from the Yoga Ed manual.

- *Concept:* How breathing helps us to control our feelings.
- *Theme:* Breathing.
- *Time-in:* Children are taught three different ways to take deep relaxing breaths (see images in Appendix A):
    1) Humming Breath: "Take a big breath in through your nose and exhale making a humming sound like a gentle bumblebee."
    2) Bunny Breath: "Twitch your nose like a bunny as you take three quick sniffs of air in through your nose. Pause and count to one, then exhale one big sigh through your mouth."
    3) Balloon Breath: "Put hands on belly and breathe deeply, feeling your belly rise like you're blowing up a balloon. Exhale and let all of the air out of your balloon slowly."

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- *Discussion:* Talk with students about how yoga helps with breathing. Ask student to share different ways to breathe and ask for examples of times they use different types of breathing (e.g., quick shallow breaths while playing soccer, slow deep breaths while resting in bed).

- *Warm-up*: Sun-Salute A (see images on Appendix A)

- *Yoga postures:* Move through a sequence of postures: Table, dragon, warrior 1, down dog, ragdoll, rock, butterfly (see images in Appendix A)

- *Partner work*: Seesaw with a partner (see image in Appendix A)

- *Relaxation:* Students lay down in resting pose and have the option to close their eyes (see image in Appendix A). The teacher guides students through balloon breathing again, while they focus on how their body moves as they breathe.

- *Class Project:* To end class, students are given paper and crayons and asked to draw how they feel when they are angry and how they feel after taking deep breaths. The goal is to discuss how breathing can help students calm down when angry.

Measures

Mindfulness. Mindfulness was operationalized as present-moment awareness and nonjudgmental acceptance of thoughts and feelings. Children completed the Child and Adolescent Mindfulness Measure (CAMM; Greco, Baer, & Smith, 2011), which is a 10-item self-report measure of mindfulness. Children rated each item on a 5-point Likert scale (0 = "never true"; 4 = "always true") to indicate how well each statement described themselves. Sample statement included: "I keep myself busy so I don't notice my thoughts or feelings," and "I push away thoughts that I don't like." All items are written so that higher ratings indicate less mindfulness. Consequently, items were reverse scored prior to creating the mindfulness score.

The ten mindfulness items were summed to create a total mindfulness score with higher scores reflecting children who are more aware of their thoughts and feelings, or who have higher levels of mindfulness. Currently, the CAMM is one of only a few measure of mindfulness adapted for children (Thompson & Gauntlett-Gilbert, 2008). Using data collected from school-aged children, Greco and colleagues (2011) computed a factor analysis using the 10 mindfulness items. Results best supported a single factor solution, with factor loadings ranging from .42 to .66. In addition, Greco and colleagues (2011) reported strong internal consistency for the mindfulness scale, with an alpha coefficient of .81. Internal consistency estimates were lower in the present study (α = .62), perhaps due to the small sample size. See Appendix B for the self-report inventory.

  Emotion regulation. Emotion regulation was measured using the Abbreviated Dysregulation Inventory (ADI; Mezzich, Tarter, Giancola, & Kirisci, 2001). Emotion dysregulation was operationally defined as a deficiency in modulating affect and related to irritability, ease of emotional arousal, and negative affect. The ADI is a 30-item measure designed to assess three aspects of dysregulation (emotional/affective, behavioral, and cognitive) in youth. For the purposes of this study, only the emotional/affective dysregulation (ED) scale was used. This subscale was adapted for parents' use and is the first known study where it is used with children under the age of 10. The ED subscale consisted of 10 items measuring poorly regulated emotional behavior. Parents were asked to indicate how well each response described their child's behavior during the last several months. Each item was rated on a 4-point Likert scale (0 = "never true"; 3 = "always true"). Sample statements included: "Has trouble controlling his/her temper" and "easily becomes emotionally upset when tired." All items were written so that higher ratings indicate greater emotion dysregulation. Consequently, items were reverse scored prior to creating the emotion regulation score. Items were summed to create a

total emotion regulation score with higher scores reflecting children who are better able to control their emotions. The ED subscale has shown good internal consistency as a measure for children 10 years and over (α = .88; Marsee, 2008). The adapted parent version for younger children used in the present study demonstrated similarly strong internal consistency (α = .94).

Attentional control. Attentional control was defined as the ability to shift, monitor, and initiate attention. Attentional control comprised a composite of three subscales: shift, monitor, and initiate, from the Behavioral Rating Inventory of Executive Functioning (BRIEF; Gioia, Isquith, Guy, & Kenworthy, 2000). Specifically, of the 8 subscales included in the BRIEF, the current study used only 24 items which created the shift, monitor, and initiate subscales. Parents answered each question regarding their children's attentional control over the past 6 months. Parents were asked to indicate how well each response described their child's behavior during the last several months. The shift subscale measures the ability to move freely from one situation, aspect, or topic to another. Sample statements included: "Becomes upset with new situations" and "thinks too much about the same topic"). The monitor subscale measures work-checking habits and personal monitoring. Sample statements included: "makes careless mistakes" and "is unaware of how his/her behavior affects or bothers others". The initiate subscale measures the ability to begin a task and generate responses, ideas, and problem solving. Sample statements included: "Needs to be told to begin a task even when willing" and "lies around the house a lot ("couch potato"). Each item was rated on a 3-point Likert scale (1 = "never"; 3 = "often"). All items were written so that higher ratings indicate greater problems with attentional control. Consequently, items were reverse scored prior to creating a total attentional control score. Items were summed to create a total attentional control score with higher scores reflecting a child who is better able to shift attention, is more aware of his/her

behavior, and is able to initiate tasks independently. Previous studies have reported varying internal consistency estimates ranging from unacceptable (α = .08) to excellent (α = .98; Gioia et al., 2000). Test -retest reliability has been reported as good (.82; Gioia et al., 2000). In the current study, internal consistency estimates were quite strong, ranging from .80 to .87. Attentional control was kept as one construct and not individual subscales because the correlation among the three subscales ranged from .73-.82.

  Anxiety. Anxiety was defined as excessive worry, fears, phobias, self-deprecation and nervousness and was assessed using the Behavioral Assessment System for Children- Second Edition (BASC-2; Reynolds and Kamphause, 2004). The Parent Rating Scale is a 150 item, parent report instrument designed to measure internalizing and externalizing symptoms among 6 to 11 year-old children. Parents rated their child's behaviors observed in the home and in the community. A total of 9 subscales are included in the BASC-2. In the current study, parents completed only the 14 items which create an index of anxiety. Parents' rated each item with regard to how well each item described their child's behavior during the past several months. Sample statements included: "Worries about what parents think" and "Is fearful." Items are rated on a 4-point Likert scale (0 = "Never"; 3 = "Almost Always"). Higher scores indicate more anxiety problems. Overall, the subscales demonstrated good internal consistency ranging from .90 to .91 (Reynolds & Kamphaus, 2004). The internal consistency estimates were not as strong in the current study, but the scores generally indicated good internal consistency (α = .81). See Appendix C for the parent-report inventory.

Data Analytic Plan

Before testing study hypotheses, study constructs were evaluated to ensure that all constructs meet normality assumptions. Next, correlations and independent sample t-tests were computed to evaluate the extent to which participants' mindfulness, attentional control, emotion regulation, and anxiety scores varied by child age, sex, race, or mindfulness experienced.

To test the first, second, and third hypotheses, mindfulness, attentional control, emotion regulation, and anxiety were correlated. Before continuing to the higher order analyses, mindfulness, attentional control, and emotion regulation scores were grand mean centered to decrease problems with multicollinearity. Interaction terms were created by multiplying the two centered constructs together. To test the fourth hypothesis, regression equations using PROCESS by Hayes (2013) were used to evaluate the extent to which mindfulness interacts with emotion regulation and attentional control to explain statistically significant portions of the variance associated with anxiety problems. Using attentional control as an example, the main effects of mindfulness, attentional control, and the mindfulness x attentional control interaction term were entered. Statistically significant interaction terms will be decomposed. These regression equations were re-estimated substituting emotion regulation for attentional control. Given the very small sample size, bootstrapping with 1,000 bootstrapped samples was used (Hayes, 2013). The bootstrapped estimation approach is appropriate to use with small samples because 1,000 random samples are computed from the sample to gain a better estimation of the population mean. Additionally, boostrapping does not rely on assumptions of normality, and is robust to violations of assumptions, thus skewed and kurtotic data does not need to be transformed (Fields, 2013).

Results

Preliminary analyses.

Sample characteristics are presented in Table 1. Table 2 summarizes the mean, standard deviation, skew and kurtosis. Mindfulness and attention control were all normally distributed. Emotion regulation scores showed a positive kurtotic distribution, indicating that most parents reported very few emotion regulation problems. However, emotion regulation will not be transformed because the bootstrapped estimation approach is appropriate for measure the violate normality assumptions (Fields, 2013; Hayes, 2013).

Next, children's age was correlated with all study constructs to ensure that child age did not account for any variability in the constructs. Age was not statistically, significantly correlated with mindfulness, attention control, or anxiety. Age was statistically significantly and positively correlated with emotion regulation, indicating that parents reported better emotion regulation among younger rather than older children ($r = -.47$; $p < .05$; see Table 3). Third, a series of independent sample t-test statistics were computed to evaluate the extent to which means of the study construct varied by child sex or previous mindfulness experienced. No t-tests were computed for child ethnicity because the overwhelming majority (87.5%) self-reported as African-American. Means of study constructs did not vary by child sex. When considering mindfulness experienced, again, no statistically significant differences emerged between children who endorsed mindfulness experienced and children who did not endorse mindfulness experienced on any of the study constructs.

Table 1. *Parent and Student Characteristics as Percentage of the Sample*

Parent			Child		
Characteristic	*n*	*%*	Characteristics	*n*	*%*
Mindfulness Experienced			Mindfulness Experienced		
Yes	6	28.6	Yes	10	41.7
No	15	71.4	No	10	41.7
Marital Status			Gender		
Single	15	62.5	Male	7	29.2
Married	4	16.7	Female	13	54.2
Divorced	1	4.2	Ethnicity		
Education Level			African American	21	87.5
< High School	1	4.2	Native American	1	4.2
High School/GED	15	62.5	Other	1	4.2
Associates	4	16.7	Grade		
≥ College	1	4.2	First	5	20.8
Free Lunch	24	100	Second	2	8.3
			Third	1	4.2
			Fourth	7	29.2
			Fifth	9	37.5

Table 2. *Descriptive Statistics for Children's Mindfulness, Emotion Regulation, Attentional Control, and Anxiety*

Variable	*n*	*M*	*SD*	Range Potential	Range Actual	Skew(SE)	Kurtosis(SE)
Mindfulness	20	2.48	.71	0-4	.80-3.60	-.28(.51)	.32(.99)
Attentional Control	19	2.24	.41	1-3	1.38-2.88	-.33(.52)	-.45(1.01)
Emotion Regulation	20	2.38	.83	0-3	0-3	-1.99(.51)	3.62(.99)
Anxiety	19	.81	.49	0-3	0-1.93	.37(.52)	-.05(1.01)

Table 3. *Correlations among Mindfulness, Self-Regulation, and Anxiety*

Variable	1	2	3	4
1. Age				
2. Mindfulness	-.03			
3. Attentional Control	-.01	.24		
4. Emotion Regulation	-.47*	.50*	-.07	
5. Anxiety	-.10	-.65**	-.55*	.12

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

Hypothesis 1

  Hypothesis 1 stated that self-regulatory skills will be correlated with each other, so that better emotion regulation will be positively correlated with better attentional control. As shown in Table 3, better emotion regulation was not statistically and significantly correlated with better attentional control.

Hypothesis 2

  Hypothesis 2 stated that self-regulatory skills, specifically emotion regulation and attentional control, will be negatively correlated with anxiety symptoms. As shown in Table 3, emotion regulation was not statistically and significantly correlated with anxiety. Instead, attentional control was statistically significantly and negatively correlated with anxiety ($r = -.55$; $p < .05$; see Table 3), suggesting that less anxiety was related to more attentional control.

Hypothesis 3

  Hypothesis 3 stated that more mindfulness skills will be correlated with better self-regulatory skills, specifically emotion regulation and attentional control, and fewer anxiety symptoms. Contrary to expectations, mindfulness was not statistically significantly correlated with attentional control ($r = .24$; see Table 3). Consistent with expectations, mindfulness was statistically significantly and positively correlated with emotion regulation ($r = .47$; $p < .05$) and negatively correlated with anxiety ($r = -.65$; $p < .01$). Specifically, more mindfulness was associated with fewer anxiety problems and better emotion regulation.

Hypothesis 4

  Hypothesis 4 stated that mindfulness will moderate the association between self-regulation and anxiety symptoms. Specifically, as levels of mindfulness increase, more

attentional control will be associated with fewer anxiety symptoms. Similarly, as levels of

mindfulness increase, better emotion regulation will be associated with fewer anxiety symptoms.

To evaluate the direct and moderating effect of attentional control and emotion regulation

with mindfulness on anxiety problems, two regression equations were computed (see Table 4,

Panel A and B) using PROCESS by Hayes (2013). The first evaluated the mindfulness x

attentional control interaction. The second evaluated the mindfulness x emotion regulation

interaction.

In the first regression equation, mindfulness, attentional control, and the mindfulness x

attentional control interaction term were entered simultaneously. The beta coefficient associated

with mindfulness was statistically significant, however the beta coefficients associated with

attentional control and the interaction term were not significant. In the second regression

equation, mindfulness, emotion regulation, and the mindfulness x emotion regulation interaction

term were entered simultaneously. The beta coefficient associated with mindfulness was

statistically significant, however the beta coefficients associated with emotion regulation and the

interaction term were not significant.

Table 4. *Results of the Regression Analysis Estimating Interactive Effects of Attentional Control*
and Emotion Regulation and Mindfulness on Anxiety

Variable	Anxiety			
	b	$SE\ B$	t	p
	Panel A: Attentional control			
Mindfulness	-.47	.13	-3.50	.00
Attentional control	-.35	.25	-1.38	.19
Mindfulness x attentional control	.60	.35	1.71	.12
	Panel B: Emotion regulation			
Mindfulness	-.60	.18	-3.35	.01
Emotion regulation	.74	.57	1.29	.22
Mindfulness x emotion regulation	.48	1.28	.37	.72

Discussion

Childhood is a developmentally important period for learning self-regulatory skills. Children with better self-regulatory skills seem to perform better academically and to experience fewer behavior problems (Diamond, 2010; Flook et al., 2010; Greenberg, et al., 2003; Mendelson, et al., 2013). Exposure to contextual stressors may undermine the development of self-regulation, specifically emotion regulation (Del Guidice et al., 2014) and attentional control (Blair & Raver, 2011, 2014), leaving children more vulnerable to experiencing a variety of emotional and behavioral problems, including anxiety (e.g., Bar-Haim et al., 2007; Zahn-Waxler et al., 2000). A theoretical model was proposed which described a process by which yoga may improve self-regulation skills and reduce risk for childhood psychopathology (see Figure 1; Bar-Haim et al., 2007; Brown & Gerbarg, 2005; Eisenberg et al., 2004; Lutz et al., 2008; Streeter et al., 2012). Four hypotheses derived from this model were tested using a small pilot study.

First, contrary to expectations, components of self-regulation were not statistically and significantly correlated. This lack of a statistical association was unexpected given previous studies suggesting that attentional control is a regulatory mechanism for emotional reactivity (Blair & Raver, 2011, 2014; Loman & Gunnar, 2010). This finding may be explained because children can experience emotion regulation problems without having attentional control problems (Zahn-Waxler, et al., 2000). Measurement concerns could explain this null finding. Attentional control was indexed by three subscales: shift, monitor, and initiate. While shift reflected children's ability to re-direct attention as needed, monitor was operationalized as work-checking and personal monitoring habits. Initiate measured the ability to begin a task or generate ideas. It may be that only the shift subscale captures emotion regulatory abilities. In fact,

according to a factor analysis by Egeland and Fallmyr (2010), the shift subscale, but not monitor or initiate, is an index of emotion regulation.

Additionally, problems with the emotion regulation measure may partially account for the unexpected results. The measure of emotion regulation used in the current study does not assess regulation. Instead, questions reflect the degree of emotional reactivity; with low reactivity scores implying regulation without directly measuring regulatory strategies (Mezzich et al., 2001). Furthermore, this measure was adapted from self-report to a parent-report index, and used with children younger than recommended (Mezzich et al., 2001).

Second, components of self-regulation were expected to be negatively correlated with anxiety symptoms such that children who were better regulated would experience fewer anxiety symptoms. While more attentional control was associated with fewer anxiety symptoms, no association between emotion regulation and anxiety symptoms emerged. Consistent with previous studies (Bar-Haim et al., 2007; Beesodo et al., 2009; Cisler et al., 2012; Ellenbogen et al., 2002; Gioia et al., 2000; Weems, 2008; Zahn-Waxler et al., 2000), better attentional control was associated with fewer symptoms of anxiety among school-aged children. In fact, the ability to control the focus of attention may help reduce problematic anxiety symptoms, such as over attending to threatening events (Liken & Applehans, 2005). Thus, interventions aimed at strengthening children's ability to control and shift their attention has clinical implications as a way to protect from developing attention-related anxiety problems (Beesodo et al., 2009; Cisler et al., 2010; In-Albon & Schneider, 2007).

Additionally, the lack of a statistical association between emotion regulation and anxiety was unexpected, given that research suggests that anxiety problems are a result of excessive worry and fear (e.g., Weems, 2008). However, not all children with emotion regulation problems

develop anxiety problems. It is possible that measurement concerns could again explain this null finding i.e., the index of emotion regulation may have captured problems more specific to externalizing behavior problems (e.g., "flies off the handle for no good reason" and "easily becomes emotionally upset when tired") rather than anxiety (Mezzich et al., 2001).

Third, mindfulness was expected to be positively correlated with self-regulatory skills and negatively associated with anxiety symptoms. This hypothesis received mixed support. As expected, more emotion regulation was associated with more mindfulness and more mindfulness was associated with fewer symptoms of anxiety. Contrary to expectations, attentional control was unrelated to mindfulness.

The statistically significant association between mindfulness and emotion regulation adds to a very small body of research demonstrating a positive relationship between mindfulness and emotional control in fourth and fifth grade students (Schonert-Reichl et al., 2015). This is the first known study to demonstrate a relationship between mindfulness and emotion regulation in children as young as first grade. This relationship suggests that children who are more aware of their emotions may be more likely to regulate emotional distress. In fact, in research with adult participants, mindful awareness is theorized to be a mechanism to regulate emotions by preventing the initial distress following a stressor from becoming maladaptive (e.g., rumination; Baer, 2003; Hozel et al., 2011b; Teper et al., 2013; Williams, 2010). These results lend support to future research examining how mindfulness may regulate emotional reactivity in children.

Mindfulness was significantly correlated with symptoms of anxiety, which is consistent with previous studies using samples of older children (i.e., Greco et al., 2011). Difficulty controlling thoughts and emotions associated with anxiety symptoms (e.g., Weems, 2008) is conceptually similar to the opposite of being mindful, where one is preoccupied with the past,

future, or worrisome thoughts (Black, 2011). Furthermore, Brown and colleagues (2011) examined the relationship between mindfulness and mental health among adolescents with mental health diagnoses (e.g., anxiety disorder). Compared to adolescents from the treatment as usual group, adolescents who participated in an 8-week mindfulness-based stress reduction intervention reported significant increases in mindfulness scores and significant reductions in anxiety scores following the intervention and at a 3-month follow-up assessment. Thus, this negative association between mindfulness and anxiety symptoms may have clinical implications for future interventions (Brown et al., 2011)

The lack of a statistically significant association between mindfulness and attentional control is surprising (Black, 2011; Brown et al., 2007; Kabat-Zinn, 2003), given previous research that suggests improving attentional control may enhance mindfulness (Baer, 2003; Brown, et al., 2007; Butzer et al., 2016; Teper et al., 2013). One possible reason for this null finding may be explained by the measure of mindfulness used in this study (i.e., the CAMM). This measure is a single factor index assessing a lack of present moment awareness and avoidance of unpleasant thoughts and feelings, and does not include attention to thoughts and feelings (Greco et al., 2011). Measuring present-moment awareness and nonjudgmental acceptance without an attentional component may not capture where children are in their development of mindfulness skills. Thus, focusing on enhancing attentional control (the first step toward becoming more mindful) may be more developmentally appropriate for young children (Baer, 2003; Brown, et al., 2007; Butzer et al., 2016; Teper et al., 2013).

Fourth, mindfulness was expected to interact with both attentional control and emotion regulation to predict anxiety symptoms. This hypothesis was not supported. However, a larger sample size would provide enough power to detect the interaction of mindfulness with

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attentional control and emotion regulation in predicting anxiety problems. In addition, a sample

of older children would reduce measurement concerns pertaining to the mindfulness index

because the CAMM has only been validated for children over nine (Greco et al., 2011). This is

problematic because it is likely that young children do not yet have the ability to fully grasp the

concept of nonjudgmental acceptance of thoughts and feelings. Thus, more advanced aspects of

mindfulness (i.e., awareness and nonjudgmental acceptance) found in older children may interact

with attentional control to predict anxiety symptoms. Specific to emotion regulation,

measurement concerns could also explain the null findings; the emotion regulation index

captured emotional reactivity characteristic of externalizing behavior problems (e.g., "slams

doors when he/she is mad"), and may not have measured anxiety-related emotion regulation

problems.

Clinical Implications

Improving children's ability to self-regulate has important clinical implications for

childhood psychopathology, such as anxiety (Beesodo et al., 2009; Cisler et al., 2010; In-Albon

& Schneider, 2007). Children who suffer from anxiety problems tend to experience physiological

and behavioral symptoms of emotion dysregulation and problems with attentional control

(Bender et al., 2012; Bloom et al., 2010; Zahn-Waxler et al., 200; Snyder et al., 2009).

Enhancing self-regulation may be especially important for children exposed to acute and chronic

stressors whose self-regulatory systems are taxed and who have limited resources to cope with

stressors (Blair, 2010; Blair & Raver, 2011; Murali & Oyebode, 2004; Roy & Raver, 2014).

Providing children with interventions aimed at developing self-regulatory processes may repair

damage caused by chronic stressors that compromise adaptive responding to acute stressors

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(Blair & Raver, 2011, 2014; Del Guidice et al., 2014; Liston, McEwen, & Casey, 2009; Loman & Gunnar, 2010).

Yoga is one such intervention that includes deep breathing exercises. These exercises may be a beneficial way for children to increase the amount of time spent in a calm and alert state, with low breath rate, low heart rate, and high vagal tone (Brown & Gerbarg, 2005). This time spent under parasympathetic control repairs allostatic damage to the PNS, ANS, and HPA axis caused by stress exposure (Brown & Gerbarg, 2005). Rebalancing the PNS, ANS, and HPA axis is especially important for children exposed to chronic stressors because rebalancing may enhance children's ability to cope with environmental demands and recover more efficiently after exposure to acute stressors (Brown & Gerbarg, 2005; Streeter et al., 2012). Moreover, with repeated practice of focused attentional awareness, new neural pathways may develop that support attentional control and emotion regulation (Gard et al., 2014; Hasenkamp & Barsalou, 2012). Again, this may be especially important for children exposed to chronic stressors because executive functions, which control attention, are compromised by stress exposure (Blair et al., 2011; DelGuidice et. al., 2014).

In fact, the National Institute of Mental Health (NIMH) National Center for Complementary and Alternative Medicine (NCCAM) recommends yoga as a beneficial mind-body therapy for children (Kaley-Isley, Peterson, Fischer, & Peterson, 2010). NCCAM suggests that yoga supports adaptive functioning among children at risk for developing mental health problems by improving autonomic and attentional processes through deep breathing and attentional control (see path d, Figure 1; Brown & Gerbarg, 2005; Gard et al., 2014; Streeter et al., 2012).

Like yoga, clinical interventions teach children principles of mindfulness in order to regulate their attention. The goal is to help children focus on the present moment and describe without providing a judgmental label (e.g., good or bad) whatever experiences arise in the present moment (Bennett & Dorjee, 2015; Coyne, McHugh, & Martinez, 2011; Lee, Semple, Rosa, & Miller, 2008; Semple, Lee, Rosa, & Miller, 2009). Children are encouraged to have an open and accepting attitude towards their thoughts and feelings and notice when their attention has wandered, then shift attention back to the present (Bennett & Dorjee, 2015; Coyne et al., 2011; Lee et al., 2008). While there is clear overlap between principles of mindfulness and these new third wave cognitive behavioral interventions, future research needs to investigate the degree to which children who participate in yoga programs in elementary school benefit from mindfulness principles beyond physiological and attentional benefits of yoga.

Since the majority of children in need of mental health services are not referred to clinicians for help (Champion, Goodall, & Rotter, 1995; Weare & Nind, 2011), access to universal, evidence-based programs in school is critical to enhance self-regulation and protect children from developing psychopathology (Raver et al., 2009; Weissberg et al., 2015). While typical social and emotional learning (SEL) interventions teach response-focused coping strategies, it is possible that yoga is a promising new method to develop self-regulation at the biological level that underlie social and emotional skills. In fact, according to Butzer and colleagues (2016), yoga and SEL programs have the same goal of enhancing five key social and emotional competencies: self-awareness, self-management, social awareness, relationship skills, and responsible decision-making (see Butzer et al., 2016 for a detailed comparison of yoga and SEL programs). It is possible that yoga may represent a new method to deliver social and emotional skills through developing self-regulation.

Limitations

Although the primary focus of this paper was to propose a novel theoretical model by which yoga may enhance self-regulatory skills and mindfulness abilities to disrupt the impact of contextual stress exposure on the development of problem behavior, a secondary focus was to evaluate patterns of associations among core constructs among a sample of at risk elementary school aged children participating in a yoga intervention. This empirical pilot study has a number of substantial limitations. First, since children were evaluated during their participation in the yoga intervention, no causal conclusions can be drawn. Similarly, data regarding the dosage of yoga received were not available. Thus, evaluating the extent to which yoga participation influenced self-regulation, mindfulness, or anxiety symptoms is not possible.

Second, very few children actually participated. Concerns about how well the sample represented the entire group of children participating in the yoga intervention exists. Additionally, only very large effects can be detected with small samples and failures to support study hypotheses may have occurred because of limited power.

Third, the sample varied considerably by child age. Without a larger sample, detecting age-related differences is not possible. Future research may want to consider the possibility that children benefit from specific components of yoga differently with age. Specifically, younger children may improve on indices of attentional control and parasympathetic control but improvements in nonjudgmental acceptance may not emerge until later (Britton et al., 2014; Noggle et al., 2012; Schonert-Reichl et al., 2015; Viafora et al., 2014).

Fourth, contextual stressors were not measured but rather inferred. The study was conducted at a charter school that enrolls at-risk and underserved children. A more comprehensive measure of contextual stressors would begin to address the question of how yoga

may be related to self-regulatory skills in children who face varying degrees of contextual stressors. Children exposed to chronic stressors may benefit more from interventions aimed to improve their self-regulatory skills compared to children who experience limited contextual stressors. Children from low stress environments may benefit less because their self-regulatory systems are less compromised from the wear and tear of stress exposure (Blair et al., 2011; DelGuidice et. al., 2014).

Fifth, emotion regulation and mindfulness measures were used with children younger than typically recommended (Frick, Barry, & Kamphaus, 2009). It is important for future studies with elementary school students to use measures of emotion regulation and mindfulness appropriate for children younger than 9 years old. However, to date there are no current mindfulness measure recommended for use with children under the age of 9 and parent-report of young children's emotion regulation skills are limited.

Sixth, emotion regulation and attentional control measured the absence of regulation and control, respectively, rather than specific self-regulatory strategies. Additionally, the subscales chosen to comprise attentional control are developmentally valid and have good internal and external validity and test-retest reliability (Gioia et al., 2000). While the subscales measure cognitive difficulties related to shifting, monitoring, and initiating attention, there is not enough data to support whether these three indices accurately represent attentional control. However, there is one study that shows significant improvements on shift, monitor, and initiate subscales with second and third grade students, who engaged in a twice weekly meditation intervention over a period of 8 weeks (Flook et al., 2010). It is important for future research to use valid measures that capture self-regulatory *competencies*, not deficits. The current study measured dysregulation, however, since yoga aims to enhance self-regulatory skills, measuring

improvement in self-regulation is critical. Lastly, indices of self-regulation were measured only by parents. As the theoretical model in this paper proposed, future studies should include biologically-based indices of attentional and physiological indices of self-regulation, such as an attention task and a measure of vagal tone.

Common to many evaluation studies, real life complications interfered with efforts to evaluate the proposed yoga-based intervention. The next section describes lessons learned from the current study. Learning from less successful evaluation efforts may strengthen future evaluation studies.

Lessons Learned for Future Yoga-Based Intervention Efforts

The process of developing a theoretically based yoga intervention and empirically evaluating this model resulted in important lessons associated with real-world interventions. The following section describes critically important lessons learned that should guide future evaluation efforts. First, before implementing any intervention, the theoretical model must be validated to ensure that measures used in the study show acceptable reliability and validity. Using contextual stressors as an example, developing a measure of contextual stress that is consistent with the theoretical approach is needed. In the proposed theory, biological responsivity is a mechanism by which yoga improves psychological adjustment. Consequently, any measure of contextual stress must include biological sensitivity to stressors. Moreover, variability in biological responsiveness across participants is needed to ensure that variation in responsiveness to stressors predicts self-regulation.

The first step in developing a measure of contextual stressors relevant to the proposed theory would involve assessments of vagal tone (e.g., RSA) during stress and non-stress situations. Vagal tone should be measured before, during, and after children participate in a

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stressful event in order to evaluate biological responsivity to stress. The Trier Social Stress Test for Children is a good candidate for measuring physiological responsivity to stress because children have to complete a stressful task (e.g., public speaking in front of a non-responsive audience; Feldman, Rosenthal, & Eidelman, 2014). Multiple assessments of vagal tone allows for a comprehensive physiological profile of responding to stressors (e.g., baseline, stress exposure, and recovery). Validating this assessment with parent, child, and teacher reports of responsiveness to stress as well as with other reliable and valid stress measures would better support using vagal tone as a biological responsivity to stress measure. Traditional measures of contextual stress include asking participants to report whether or not a variety of negative life events have occurred in the past 12 months. Investigators create an index of cumulative risk exposure. Theoretically, biological responsivity to stress should be associated with a cumulative risk index such that fewer risk events is associated with more responsivity, but as the number of negative life events increases, biological responsivity diminishes.

The study of contextual stress exposure would be advanced by combining measures of cumulative risk exposure and biological responsivity to stress to create stress profiles (Lanza, Rhoades, Greenberg, Cox, 2011). Such profiles could address the question as to whether yoga does in fact buffer the negative impact of contextual stressors on self-regulation and how yoga may differentially affect children with various stress profiles.

Second, strong partnerships between the research team and administration is needed. In the current study, the school principal and teachers were willing to participate but did not actively support the study. Even after the administration approved adding the yoga intervention, schedule changes prevented collecting pre- and post-test data. Collecting data only once from participants does not allow for examining change over time. Developing true partnerships

between school administrators and researchers means working together to modify interventions. Building partnerships with administrators, teachers, parents and researchers is essential to successfully implement and evaluate school-based interventions (Durlak et al., 2011). Perhaps most important among these relationships is the cohesiveness of the administration and research team.

When the research team and the administrative team do not work together cohesively, the investment of the teachers and parents is diminished. Very few parents agreed to participate in the evaluation, perhaps because they did not appreciate the importance of the intervention for the school and their child. Even fewer teachers completed surveys and compensation was not a strong enough incentive to participate. The research team is responsible for increasing the awareness of the potential benefits of yoga to student classroom behavior to the administration and teachers. Had teachers been more aware of the potential benefits for the behaviors in their classroom, teachers may have been more active supporters and encouragers of parent and child participation. Administrative and teacher support may be especially important for families who face chronic stressors, such as poverty, because they experience more barriers to engaging in their children's school activities (e.g., McLoyd, 1998).

Third, using manualized interventions with fidelity checks helps target why change occurred (Greenberg & Harris, 2012). Without detailed descriptions of timing and duration of the intervention and clear descriptions of instructor training and qualifications, determining which components of the intervention affected change is not possible. The current study lacked any fidelity checks. Using fidelity checks, such as tracking children's active engagement in yoga and monitoring adherence to the manual, are important to understanding how well the results from the study can be attributed to the intervention. Basic information that should be collected during

each of day the intervention is implemented includes: frequency of participation, class length, student attendance, and student engagement (e.g., active participation). Without understanding how much of the intervention students received, clarifying the required dosage to affect change is not possible.

Fourth, interventions need to be developmentally sensitive to understand how mindfulness-based programs may be effective across childhood (Greenberg & Harris, 2012). The current study aimed to include children in elementary school. To make interventions developmentally sensitive, yoga class length and content may need to vary by the age of the students. The yoga curriculum used in the current study was designed by yoga educators with a goal to foster fitness and teach children to effectively deal with contextual stressors (https://www.yogaed.com/about). Slightly different manuals exist for children and adolescents. The manuals focus on child development and behavior management strategies. Furthermore, within each manual are suggestions for how to make class appropriate for different grades based on their age and ability (http://yogaed.com). Using manualized programs that teach age-appropriate activities and behavior management strategies is beneficial to use with children because they provide strategies for how to maximize the benefits of the curriculum across developmental levels. However, more research is needed to evaluate the effectiveness of this curriculum.

Fifth, measures need to be developmentally sensitive. Since children as young as 6 years participated, variations in the validity of measures for this age group occurred. Parents reported on children's emotion dysregulation using a measure originally designed as self-report for adolescents. The self-report measure of mindfulness was too advanced for children under the age of 10 (Greco et al., 2011). Using self-report questionnaires for children younger than the age for

which the measure was validated may diminish the reliability and validity of the measure (Frick, Barry, & Kamphaus, 2009). Instead, future studies should measure indices of parasympathetic control (e.g., RSA) and attention (e.g., flanker task), because the proposed model describes self-regulation through attentional and parasympathetic control. Additionally, the utility of measuring mindfulness in elementary school-age children is an important empirical question.

To develop age-appropriate mindfulness assessments, future studies should investigate how components of mindfulness (i.e., attention, awareness, nonjudgmental acceptance) relate to yoga engagement and self-regulation at different developmental stages. While nonjudgmental acceptance may be an important component of mindfulness with adults (Rahl et al., 2016; Teper et al., 2013), it is unclear at which age children develop the cognitive abilities for nonjudgmental acceptance of thoughts and feelings (e.g., Lawlor et al., 2013). Additionally, because attention and awareness are components of attention regulation (Gioia, 2000), measures of mindfulness may capture the same variance as measures of attention regulation, depending on how each measure is operationalized. Taken together, this questions the utility of measuring mindfulness in young children.

In conclusion, the model described in this paper theorized participation in yoga as both a potential tool for reducing children's risk for problem behavior by way of strengthening self-regulatory mechanisms and as a buffer against the adverse effects of contextual stressors. While findings were mixed, results were encouraging and support the need for critical next steps—continued high-quality implementation and evaluation of this theoretical model.

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Appendices

Appendix A. *Sample Yoga Ed Poses*

Humming Breath

Instructions:

1. Inhale through your nose.

2. Exhale, making the sound "hmmm" like a gentle bumblebee.

Bunny Breath

Instructions:

1. Twitching your nose like a bunny, inhale 3 quick sniffs through your nose.

2. Pause for one count.

3. Exhale a big sigh through your mouth.

Balloon Breath

Instructions:

1. Place one or both hands on your belly and breathe deeply. Inhale, feeling your belly rise.

2. Exhale, feeling your belly lower and contract.

Balloon Breath 1   Balloon Breath 2

64

Sun Salute A

Instructions:

1. Begin in Mountain Pose.

2. Inhale, arms reach up and overhead.

3. Exhale, hinge from the hips and fold forward.

4. Inhale, hands on the shins or ground, lengthen the spine, and gaze up.

5. Exhale, step the legs back to Table Pose.

6. Lower into push-up or tummy to ground.

7. Inhale to Cobra Pose or Upward Dog.

8. Exhale to Table Pose.

9. Press back to Downward Dog.

10. Inhale, walk the feet forward to the hands, the hands on the shins or floor, find length in the spine.

11. Exhale, fold forward.

12. Inhale, rise as you arms reach up.

13. Exhale, lower your arms back to Mountain Pose.

Sun Salute cont'd.

1

2

3

4

5

6

7

8

9

10

11

12

13

Table

Dragon

Warrior 1

Down dog

Ragdoll

Rock

Butterfly

Seesaw

Resting Pose

Appendix B. *Child Survey*

Participant ID: _____

The Yoga Study
.

_____   _____

Print Name   Date

Birthday: _____ (MM/DD/YYYY)   Age: _____

Ethnicity: Grade: Past Yoga Experience: Past Meditation Experience:

○   Asian/Pacific Islander   ○   1st   ○   Yes   ○   Yes
○   Black/African-American   ○   2nd   ○   No   ○   No
○   Hispanic/Latino   ○   3rd
○   Native American   ○   4th
○   White/Caucasian   ○   5th
○   Other (specify): _____ ○   6th

What is your gender?
○   Male
○   Female

CAMM

Instructions
Please read each statement and decide how well it describes you. Mark your answer by filling in the appropriate bubble (Never true-Always true) for each statement. Do not leave any statement unrated.

	Never True	Rarely true	Sometimes true	Often true	Always true
1. I get upset with myself for having feelings that don't make sense………………………………………	○	○	○	○	○
2. At school, I walk from class to class without noticing what I'm doing……………………………………	○	○	○	○	○
3. I keep myself busy so I don't notice my thoughts or feelings…….	○	○	○	○	○
4. I tell myself that I shouldn't feel the way I'm feeling……………	○	○	○	○	○

5. I push away thoughts that I don't like……………………………………   ○   ○   ○   ○   ○

6. It's hard for me to pay attention to only one thing at a time………   ○   ○   ○   ○   ○

7. I think about things that happened in the past instead of

   thinking about things that are happening right now……………   ○   ○   ○   ○   ○

8. I get upset with myself for having certain thoughts………………   ○   ○   ○   ○   ○

9. I think that some of my feelings are bad and that

   I shouldn't have them……………………………………………   ○   ○   ○   ○   ○

10. I stop myself from having feelings that I don't like………………   ○   ○   ○   ○   ○

Participant ID: _____

The Yoga Study

We would like your help completing this survey. Please answer every question as best you can. Upon completion, please place this packet in the small addressed and stamped envelope along with your singed Parent Informed Consent Letter (the first page).Then, please put the envelope in the mail to us. Thank you for your time!

Please make your best effort to return this by November 7th, 2014

_____   _____

Print Your Name   Date

_____

Print Your Child's Name

PARENT'S BACKGROUND INFORMATION

Parent's birthday: _____ (MM/DD/YYYY)　　Your Age: _____

Child's birthday: _____ (MM/DD/YYYY)　　Child's Age: _____

Parent's ethnicity:　　　　　　　Marital Status:

○　　Asian/Pacific Islander　　　　○　　Single (Never Married)

○　　Black/African-American　　　　○　　Widowed

○　　Hispanic/Latino　　　　　　　○　　Divorced

○　　Native American　　　　　　　○　　Married

○　　White/Caucasian

○　　Other (specify): _____

Have you ever done Yoga?

Education Level:　　　　　　　　　　　　　　　　○　　No

○　　Less than High School Degree　　　　　　　○　　Yes

○　　High School Graduate or GED　　　Have you ever Meditated?

○　　Associates Degree　　　　　　　　　　　　○　　No

○　　College Degree or Higher　　　　　　　　　○　　Yes

My child qualifies for:

○　　Free Lunch

○　　Reduced Payment for Lunch

○　　Neither, We pay for Lunch

BRIEF

	Never a problem	Sometimes a problem	Often a problem
1. Is not a self-starter.	O	O	O
2. Resists or has trouble accepting a different way to solve a problem with schoolwork, friends, chores, etc.	O	O	O
3. Becomes upset with new situations.	O	O	O
4. Tries the same approach to a problem over and over even when it does not work.	O	O	O
5. Needs to be told to begin a task even when willing.	O	O	O
6. Acts upset by a change in plans	O	O	O
7. Is disturbed by change of teacher or class	O	O	O
8. Does not check work for mistakes.	O	O	O
9. Has trouble coming up with ideas for what to do in play or free time.	O	O	O
10. Makes careless errors.	O	O	O
11. Resists change of routine, foods, places, etc.	O	O	O
12. Has trouble getting used to new situations (classes, groups, friends).	O	O	O
13. Has poor handwriting.	O	O	O
14. Is unaware of how his/her behavior affects or bothers others.	O	O	O
15. Thinks too much about the same topic.	O	O	O
16. Does not notice when his/her behavior causes negative reactions.	O	O	O
17. Has trouble getting started on homework or chores.	O	O	O
18. Has trouble organizing activities with friends.	O	O	O
19. Has poor understanding of own strengths and weaknesses.	O	O	O
20. Work is sloppy.	O	O	O
21. Does not take initiative.	O	O	O
22. Does not realize that certain actions bother others.	O	O	O
23. Complains there is nothing to do.	O	O	O
24. Lies around the house a lot ("couch potato").	O	O	O

BASC-2 PRS

Instructions:
On the pages that follow are phrases that describe how children may act. Please read each phrase, and fill in the circle of the response that describes how this child has behaved recently (in the last several months). Please mark every item. If you don't know or are unsure of your response to an item, give your best estimate.

	Never occurs	Sometimes occurs	Often occur	Almost always occurs
1. Worries………………………………………………….…...	O	O	O	O
2. Cannot wait to take turn……………………………………	O	O	O	O
3. Teases others. …………………………………………….	O	O	O	O
4. Has a short attention span…………………………………	O	O	O	O
5. Is easily upset……………………………………………...	O	O	O	O
6. Does strange things……………………………………….	O	O	O	O
7. Worries about what teachers think…………………………….	O	O	O	O
8. Is too serious………………………………………………	O	O	O	O
9. Disobeys……………………………………………………	O	O	O	O
10. Makes friends easily………………………………………	O	O	O	O
11. Pays attention……………………………………………..	O	O	O	O
12. Complains about being teased……………………………	O	O	O	O
13. Is unable to slow down……………………………………	O	O	O	O
14. Refuses to join group activities…………………………..	O	O	O	O
15. Babbles to self……………………………………………	O	O	O	O
16. Bullies others…………………………………………….	O	O	O	O
17. Will change direction to avoid having to greet someone……………………….	O	O	O	O
18. Hits other children……………………………………….	O	O	O	O
19. Cries easily……………………………………… …………	O	O	O	O
20. Steals………………………………………………………	O	O	O	O
21. Expresses fear of getting sick…………………………….	O	O	O	O
22. Worries about making mistakes…………………………..	O	O	O	O
23. Worries about what parents think…………………………	O	O	O	O
24. Disrupts other children's activities……………………….	O	O	O	O
25. Argues with parents………………………………………	O	O	O	O
26. Listens to directions………………………………………	O	O	O	O

27. Says, "Nobody understands me.".. O O O O

28. Acts confused.. O O O O

29. Worries about schoolwork.. O O O O

30. Is fearful... O O O O

31. Breaks the rules... O O O O

32. Avoids competing with other children...................................... O O O O

33. Pays attention when being spoken to....................................... O O O O

34. Complains about not having friends.. O O O O

35. Acts out of control... O O O O

36. Is chosen last by other children for games................................ O O O O

37. Complains of pain... O O O O

38. Repeats one though over and over.. O O O O

39. Argues when denied own way.. O O O O

40. Is shy with other children... O O O O

41. Threatens to hurt others.. O O O O

42. Has stomach problems.. O O O O

43. Says, "Nobody likes me.".. O O O O

44. Lies to get out of trouble.. O O O O

45. Says, "I think I'm sick.".. O O O O

46. Tries too hard to please others... O O O O

47. Is nervous.. O O O O

48. Fiddles with things while at meals.. O O O O

49. Annoys others on purpose.. O O O O

50. Is easily distracted.. O O O O

51. Is negative about things.. O O O O

52. Seems out of touch with reality... O O O O

53. Worries about things that cannot be changed............................... O O O O

54. Deceives others... O O O O

55. Quickly joins group activities.. O O O O

56. Says, "I don't have any friends.".. O O O O

57. Is overly active.. O O O O

58. Has headaches... O O O O

59. Acts as if other children are not there................................... O O O O

60. Seeks revenge on others………………………………………… O O O O

61. Shows fear of strangers……………………………………… O O O O

62. Loses temper too easily……………………………………… O O O O

63. Complains about health……………………………………… O O O O

64. Says "I want to die" or "I wish I were dead."……………………… O O O O

65. Sneaks around………………………………………………… O O O O

66. Gets sick……………………………………………………… O O O O

67. Seems unaware of others……………………………………… O O O O

68. Says, "I'm afraid I will make a mistake."……………………… O O O O

69. Interrupts others when they are speaking……………………… O O O O

70. Calls other children names…………………………………… O O O O

71. Listens carefully……………………………………………… O O O O

72. Says, "I hate myself."………………………………………… O O O O

73. Hears sounds that are not there……………………………… O O O O

74. Says, "I'm not very good at this."…………………………… O O O O

75. Lies…………………………………………………………… O O O O

76. Avoids other children………………………………………… O O O O

77. Is sad………………………………………………………… O O O O

78. Acts without thinking………………………………………… O O O O

79. Has fevers…………………………………………………… O O O O

80. Stares blankly………………………………………………… O O O O

81. Has trouble making new friends……………………………… O O O O

82. Is afraid of getting sick……………………………………… O O O O

83. Seems lonely………………………………………………… O O O O

84. Breaks the rules just to see what will happen………………… O O O O

85. Complains of being sick when nothing is wrong……………… O O O O

86. Says things that make no sense……………………………… O O O O

87. Says, "It's all my fault."……………………………………… O O O O

88. Interrupts parents when they are talking on the phone………… O O O O

89. Is cruel to others……………………………………………… O O O O

90. Says, "I want to kill myself."………………………………… O O O O

91. Sees things that are not there………………………………… O O O O

92. Worries about what other children think……………………… O O O O

93. Prefers to be alone... ○ ○ ○ ○

94. Has poor self-control... ○ ○ ○ ○

95. Vomits.. ○ ○ ○ ○

96. Shows feelings that do not fit the situation...................... ○ ○ ○ ○

97. Is shy with adults... ○ ○ ○ ○

98. Changes moods quickly.. ○ ○ ○ ○

99. Gets into trouble... ○ ○ ○ ○

100. Complains of shortness of breath.................................. ○ ○ ○ ○

101. Acts strangely... ○ ○ ○ ○

ADI-ED

Instructions:
Below are phrases that describe how children may act. Please read each phrase, and fill in the circle of your response that describes how this child has behaved recently (in the last several months). Please mark every item. If you don't know or are unsure of your response to an item, give your best estimate.

	Never true	Occasionally true	Mostly true	Always true
1. Has trouble controlling his/her temper..	○	○	○	○
2. Loses sleep because he/she worries....................................	○	○	○	○
3. When angry, loses control over his/her actions........................	○	○	○	○
4. Gets so frustrated that he/she often feels like a bomb ready to explode..................	○	○	○	○
5. Flies off the handle for no good reason...............................	○	○	○	○
6. There are days when he/she is "on edge" all the time........................	○	○	○	○
7. Easily becomes emotionally upset when tired...........................	○	○	○	○
8. Often is afraid that he/she will lose control of his/her feelings........................	○	○	○	○
9. Slams doors when he/she is mad..	○	○	○	○
10. Mood goes up and down without reason..............................	○	○	○	○

Vita

The author was raised in Saratoga Springs, New York. She obtained her Bachelor's degree in Psychology with a minor is Sociology from Clemson University in 2008. In August 20011, she obtained her Master's degree in General Psychology from the University of North Carolina Wilmington. The author joined the University of New Orleans Applied Developmental Psychology program in 2013.