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Attachment and Internalizing and Externalizing Problems in Adolescence: Exploring the Mediating Role of Physiological Self-Regulation Capacity

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Attachment and Internalizing and Externalizing Problems in Adolescence:

Exploring the Mediating Role of Physiological Self-Regulation Capacity

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Abstract

Internalizing and externalizing problems impact functioning and health in adolescence. Therefore, understanding risk and protective factors related to these behaviors is of practical interest. The proposed study examined the relationship between parent-adolescent attachment security, self-regulation capacity, and internalizing and externalizing problems. Previous studies have supported prospective links between parent-child attachment security and self-regulation capacities. Similarly, self-regulation is as a protective factor from internalizing and externalizing problems. This study proposed a mediation model combining these findings. It was hypothesized that youth with stronger parent-adolescent attachment security would demonstrate fewer internalizing and externalizing problems, and that this relationship would be mediated by better physiological self-regulation capacity among youth with stronger attachment. Attachment was measured through parent report of their own attachment behaviors, and child report of attachment security with their parents. Results supported the hypothesis that greater parent-adolescent attachment security would be related to fewer internalizing (cross-sectional β = -3.38, p < .00; longitudinal β = -4.34, p < .00) and externalizing problems (cross-sectional β = -3.63, p < .00; longitudinal β = -3.92, p < .00). However, results including physiological self-regulation capacity were unexpected. Child rated attachment security was not significantly related to regulation capacity (β = -.16, p = 0.28); while, greater parent attachment behaviors were significantly related to poorer, not better, physiological self-regulation capacity (β = -.31, p = 0.02). Mediation analyses

revealed two models trending towards significance; though no models reached

significance based on a 95% confidence interval. Models trending toward significance

included the effect of parent attachment behaviors on externalizing problems through

physiological self-regulation capacity prospectively (β = .18, 95% CI [-.02, .57]) and

concurrently (β = -.24, 95% CI [-.80, .08]). However, within these models, greater parent

attachment behaviors were related to lower, not greater, physiological self-regulation

capacity, making theoretical interpretation of findings less clear. Interpretation and

implications of these findings are discussed.

CHAPTER I

Introduction and Literature Review

Purpose

Developmental psychopathology research has identified two key domains of psychological impairment among youth, typically described as internalizing and externalizing problems. Internalizing problems include depressive, anxious, and somatic symptoms, while externalizing problems include aggression and hyperactivity. Cumulative rates of externalizing and internalizing disorders in childhood and adolescence range from 4.1% (attention deficit hyperactivity disorder [ADHD]) to 23.0% (oppositional defiant and conduct disorders) (Costello, Mustillo, Erkanli, Keeler, & Angold, 2003). Rates of subclinical symptoms are even higher, and remain impairing for many children (Buist, Deković, Meeus, & van Aken, 2004). Internalizing and externalizing domains of impairment were identified to scaffold understanding of impairing symptoms across diagnostic categories.

While many risk factors for mental health problems in youth have been identified, poor self-regulatory capacity has been associated with both internalizing and externalizing problems (Buckholdt, Parra, & Jobe-Shields, 2014). Self-regulation has been defined as the ability to override autonomic tendencies or automatic behaviors in order to enact behaviors and physiological reactions that are in line with long-term goals (Carver & Scheier, 2004). Self-regulatory capacity refers to the availability of physiological and psychological resources necessary to self-regulate; this capacity is dependent on the strength of an individual's self-regulatory skills and biological systems supporting self-regulation (Vohs & Baumeister, 2016). Individuals who have higher self-

regulation capacity have fewer internalizing and externalizing behaviors (Eisenberg, Spinrad, & Eggum, 2010).

Physiological indices may provide a less biased method of assessing self-regulatory capacity than using self or observer report. Resting respiratory sinus arrhythmia (RSA) has been proposed as one such physiological index. RSA is hypothesized to be a peripheral index of parasympathetic activation and prefrontal activation, two physiological systems key to self-regulatory capacity. High resting RSA is hypothesized to index a high capacity for self-regulation. It has been linked to better self-regulation in stressful situations, fewer psychological disorders, and general expressions of emotionality and engagement with one's environment across adolescence and adulthood (for a review see Beauchaine, 2001; Beauchaine & Thayer, 2015). Conversely, low resting RSA is purported to predict lower self-regulation capacity and the emergence of externalizing behaviors and depressive symptoms in adolescents in middle and early high school (El-Sheikh, Arsiwalla, Hinnant, & Erath, 2011; Hinnant & El-Sheikh, 2013; Mezulis, Crystal, Ahles, & Crowell, 2015).

While the link between self-regulation and internalizing and externalizing problems is strong, relatively less research has examined factors contributing to the development of strong physiological self-regulation capacity in adolescence. Developmental models suggest that securely attached parent-child relationships – those that provide emotional and physical safety, security, and availability – foster the development of better self-regulatory capacity (Schore, 2001). Securely attached relationships allow children and adolescents to develop adaptive self-regulatory behaviors, schema of self-efficacy in self-regulation, and well-adapted biological and

physiological systems that support self-regulation. This developmental model may be particularly salient in the transition to adolescence, which is a time of marked plasticity and development in self-regulation (Belsky & Beaver, 2011; Zelazo & Carlson, 2012). Over this time period, adolescents who achieve these developmental tasks shift from co-regulating with their parents to having the ability to self-regulate in increasingly demanding situations (Cooper, Shaver, & Collins, 1998).

The purpose of this study is to examine how parent-adolescent attachment security may predict self-regulatory capacity (indexed by resting RSA), which may in turn be associated with child internalizing and externalizing problems. A mediation model was proposed wherein more securely attached parent-child relationships predict higher physiological self-regulatory capacity, and fewer internalizing and externalizing problems. Conversely, it was hypothesized that children with poorer attachments would fail to develop a strong capacity for self-regulation, and thus be more likely to display internalizing and externalizing problems.

The following literature review will explore the constructs used within this study. Internalizing and externalizing problems will be supported as valid and useful constructs in the understanding of and prevention of psychopathology in youth. Next, literature will be reviewed linking secure attachment to protection from internalizing and externalizing problems. Finally, the mechanism by which attachment security protects adolescents from internalizing and externalizing problems will be explored. Attachment security will be explored as a way of understanding how dyadic parent-child interactions scaffold the development of systems for co and subsequently, self-regulation, leading to less psychopathology.

Internalizing and Externalizing Problems among Youth

      Definitions. Achenbach coined the terms internalizing and externalizing dysfunction over fifty years ago. At the time, several theories posited that similarities existed among the symptoms of diagnostic labels used within the field of adult psychopathology. Adult psychopathology researchers had divided symptomatology into categories characterized by the tendency of individuals to either engage in 'withdrawal from others… and turning against the self' or 'thoughts or actions turned against others… and self-indulgence' (Phillips & Rabinovitch, 1958, pp. 182). In his seminal work, Achenbach used factor analytic methods to search out underlying commonalities among psychopathology in youth. He was successful in his search, finding that most psychological symptoms common in youth loaded onto two major factors. He termed these factors internalizing, which was akin to 'turning against the self', and externalizing, which was reflective of 'turning against others.' In this first study, symptoms within the internalizing domain included anxiety, depression, obsessions and compulsions, and somatic complaints. Externalizing symptoms included aggressive and delinquent behavior, sexual problems, and hyper-reactive behavior (Achenbach, 1966).

      Definitions of internalizing and externalizing symptoms have remained much the same since the original definition of these constructs in the 1960s. Currently, internalizing symptoms are generally agreed to fall within depression, anxiety, obsessive-compulsive, traumatic stress, somatic, and suicidal and self-injurious symptom profiles. Externalizing symptoms are diagnostic hallmarks of conduct and disruptive behavior disorders (Krueger, Caspi, Moffitt, & Silva, 1998). Attention deficit and hyperactivity symptoms are less reliably clustered with externalizing symptoms, with some factor

analyses finding these symptoms are independent of internalizing or externalizing domains (Hewitt et al., 1997). This departure from the historical clustering of attention deficit and hyperactivity clustering with externalizing problems may reflect a growing understanding of the role of higher order executive functions as a common risk factor to internalizing and externalizing symptoms (Hughes & Ensor, 2011; Weyandt et al., 2014). As such, attention deficit and substance use were not included in definitions of internalizing and externalizing problems for this study.

Finally, Achenbach originally classified individuals as internalizing or externalizing if over 60% of their symptoms fell within a single category (Achenbach, 1966). The remaining individuals were uncategorized. This conceptualization is used less often in recent work, which focuses more heavily on measuring occurrence of full symptom profiles of disorders falling within internalizing and externalizing categories, or on sub-clinical symptoms of internalizing or externalizing disorders, as in the current study (Oldehinkel, Hartman, De Winter, Veenstra, & Ormel, 2004). Investigating dysfunction on a symptom or 'problem' level is helpful as it frees researchers to understand commonalities among groupings of commonly experienced symptoms, regardless of diagnostic status.

Epidemiology. Epidemiological data demonstrates the necessity of understanding internalizing and externalizing problems in youth, as most internalizing and externalizing problems have roots in childhood and adolescence (Patel, Flisher, Hetrick, & McGorry, 2007). Prevalence rates across adolescence demonstrate the pervasiveness of these problems. Over 1 in 4 youth will have an internalizing disorder in adolescence, and nearly 1 in 5 will meet criteria for an externalizing disorder (Merikangas et al., 2010).

Twelve-month prevalence of DSM disorders among adolescents – the number of existing cases in a population over 12 months – is high, with 40 percent of youth meeting criteria for at least one diagnosis (Merikangas et al., 2010).

Externalizing problems. Externalizing problems generally onset in middle childhood or the transition to adolescence. Data indicating onset of problems come from several methods of epidemiological analysis. Mean age of onset gives an average age of problem onset across the population, from birth to death. For impulse-control disorders, including oppositional defiant, conduct, attention deficit and hyperactivity, and intermittent explosive disorders, the mean age of onset is 11 years (Kessler et al., 2005). Age of onset distributions, which investigate onset using a normal curve to indicate an age span during which most problems onset, place the median age of onset of any externalizing disorder even lower, at 7-9 years. When viewed as discrete disorders, most externalizing problems onset within mid and late childhood; however, conduct disorder (9-14 years) and intermittent explosive disorder (13-21 years) generally emerge later in adolescence and early adulthood. Externalizing disorders are unique among other clusters of symptomatology in their narrow band of onset, with 80% of children who develop externalizing disorders showing full symptom profiles during childhood and adolescence (Kessler et al., 2007).

In any twelve month period, 16% of children and adolescents meet full criteria for an externalizing disorder (Kessler et al., 2012). When this time period is extended to a child's 'lifetime,' over their first 18 years, this rate increases to 18% (Merikangas et al., 2010). This small difference between twelve-month and youth prevalence may indicate the pervasiveness of behavioral problems after onset. Many epidemiological studies

indicate presence of symptom profiles, but do not assess impairment associated with a clinical diagnosis. When severe impairment (severity necessary to receive clinical treatment) is considered, 18 year lifetime prevalence falls to 9.6% (Merikangas et al., 2010). This difference between rates of severe impairment and rates of full symptom profiles exemplifies the need to consider *problems* and *symptoms* as opposed to only *disorder*. According to these epidemiological studies, many youth experience personally, if not clinically or diagnostically, significant symptoms. Failing to study or intervene upon these symptoms until they reach diagnostic significance impairs primary prevention efforts and leaves children vulnerable to impairment. Regarding course of externalizing symptoms, problems generally onset in childhood and decrease in prevalence throughout adolescence (Fanti & Henrich, 2010; Kessler et al., 2005). In summary, up to 18% of children develop distressing externalizing problems, which usually onset around ages 7-11 and usually decrease steadily throughout adolescence.

Internalizing problems. Internalizing problems demonstrate a more dispersed age of onset distribution than externalizing problems. This is reflected in wider and older estimates of mean age of onset. Estimates for anxiety disorders generally fall between ages 6 and 11 and mood disorders between 13 and 20 years (Kessler et al., 2005; Merikangas et al., 2010). Without considering impairment, rates of anxiety disorders are much more prevalent than mood disorders. Within any year during adolescence, prevalence estimates for rates of anxiety disorders are 24% and mood disorders are 10% (Kessler et al., 2012). Lifetime prevalence over the first 18 years of life follows 12-month prevalence trends, with anxiety (31%) demonstrating higher rates than mood disorders (14%) (Merikangas et al., 2010). When severe dysfunction is considered, lifetime (18

year) prevalence falls for all internalizing disorders. Clinically impairing mood disorders occur within 11.2% of the adolescent population, while clinically impairing anxiety disorders make up 8.3% (Merikangas et al., 2010). The vast difference between the 31% of the population with anxiety symptoms, and 8.3% with an impairing condition demonstrates the prevalence of sub-clinical distress. Similarly to externalizing problems, this large group of sub-clinically impaired youth is important to study and understand, especially in support of prevention efforts. Regarding symptom trajectories, internalizing symptoms generally onset in late childhood and adolescence, persisting and increasing in prevalence over adolescence and into adulthood (Fanti & Henrich, 2010; Kessler et al., 2005). In summary, more than 30% of children develop distressing mood or anxiety problems, which usually onset before age 18 and usually increase steadily throughout adolescence and early adulthood.

Co-occurring problems. Among adolescents with co-occurring internalizing and externalizing problems, two developmental trends emerge. Most youth with co-occurrence have shown high levels of both problems over childhood and into adolescence; however, some children who have had significant combined symptoms show a decrease in externalizing problems throughout early adolescence (Fanti & Henrich, 2010). The variety of trajectories among adolescents with internalizing and externalizing problems suggests myriad factors that affect a child's outcomes in adolescence. Etiological investigation has uncovered some of these determining factors.

Links to attachment and self-regulation. Internalizing and externalizing symptoms have served as a useful heuristic in developmental psychopathology research, aiding in the understanding of intrinsic and environmental determinants of different

symptom profiles (Levesque, 2014). Much of the utility in grouping symptoms of dysfunction into internalizing and externalizing problems comes with the ability to understand the etiology and course of these problems in youth. Research has pointed to shared and distinct etiological factors, including temperament, genetics, and environmental risk factors. This study focuses on two common factors to internalizing and externalizing problems, the parent-child attachment relationship and, perhaps resultant, self-regulatory capacities.

Attachment Security

Attachment security is a concept that remains relevant from early infancy through adulthood. And, while the concept changes slightly in response to shifting needs across the lifespan, generally, attachment security refers to the degree to which a relationship partner can depend on another for proximity, safety, and responsiveness to their emotional and physical needs. A child's secure attachment to their caregiver (most often described as the mother) supports the child's development through allowing the child to explore their environment with the knowledge that their parent is available as a safe haven from stressors and secure base to return to when distressed (Ainsworth, Blehar, Waters, & Wall, 2015). Attachment theory has grown with our ever-expanding understanding of biopsychosocial connections. Recent work has linked childhood attachment security to a variety of positive outcomes across adolescence, including to the development of biological and physiological self-regulation capacities and protection from internalizing and externalizing problems (Schore, 2001, 2017).

Bowlby and Ainsworth's attachment theory. Attachment theory grew out of psychodynamic and ethological theory. In its earliest conceptualization, Bowlby asserted

that within a securely attached relationship, mothers act as a child's ego and superego, regulating the child before the child has the ability to regulate him or herself. The role of the skilled mother, he stated, is to transfer the role of self-regulation on to their child through the experience of a continually positive and responsive, securely attached, parent-child relationship (Bowlby, 1951). Though it grew from psychodynamic theory, this conceptualization of a longstanding, close, even co-dependent, mother-child relationship as adaptive, stood in stark contrast to psychoanalytic thought that attachment behaviors indicated regression or stagnation in the failure to revolt against one's parents (Bretherton, 1992).

Intrigued by Bowlby's theories, Mary Ainsworth set out to observe these phenomena in mother-child dyads. Her seminal work identified three patterns of attachment: secure, insecure, and not yet attached (Ainsworth, 1963). Later work added nuance to this original structure, expanding the number of classifications to four: secure, insecure avoidant, insecure ambivalent/resistant, and disorganized. Infants with secure attachments use their mothers as secure bases from which to explore their environments, returning to their mother to be soothed when distressed. Insecurely attached infants are unable to use their mothers in this self-regulatory capacity. Avoidant children do not expect a parent to be responsive to their needs. Ambivalent/resistant children are unsure of the response they may receive from their parents, leading to oscillation between clinging, and rejecting attempts by the parent to soothe them. Disorganized attachments are characterized by a fear reaction in response to a caregiver (Ainsworth & Bell, 1970; Main & Solomon, 1990).

One of the most enduring messages of attachment theory was the indication of the importance of maternal sensitivity, warmth, and responsiveness in creating a strong and protective bond between caregiver and child. Despite common parenting advice at the time of this theory's development, responsiveness was not described as 'spoiling' a child; but rather, helping a child 'develop confidence in his own ability to control what happens to him' (Bell & Ainsworth, 1972, p. 1188; Bretherton, 1992). This pattern of responsivity is transmitted to a child who has experienced safety and support in their securely attached parent-child relationship, through the development of a positive internal working model of the attachment figure and self. In this positive internal working model, the self is competent to navigate interactions with others and others are positive interaction partners (Foss, 1969). As a consequence of this positive pattern of experience, children with secure attachments have better outcomes across a range of domains including social, cognitive, behavioral, and academic skills (Bohlin, Hagekull, & Rydell, 2000; Groh et al., 2014; Jacobsen, Edelstein, & Hofmann, 1994; Oldfield, Humphrey, & Hebron, 2016; Suess, Grossmann, & Sroufe, 1992). Ainsworth noted differences emerge within months of birth, with children who received early responsiveness demonstrating better self-regulation and social communication within the first year of life (Bell & Ainsworth, 1972).

Neurobiology of secure attachment. Recent research such as Schore's neurobiological theory of attachment, has aimed to broaden our understanding of parent-child attachment by examining neurological changes underlying attachment security. There are several important assertions core to this theory: youth experience periods of rapid and diffuse brain development across childhood, maturation of critical brain regions

depends on dyadic interaction, and positive dyadic interactions lead to biological and genetic changes that enhance adaptive self-regulatory development (Schore, 2001, 2017).

Periods of rapid brain development. Brain regions associated with emotional and behavioral control, such as the prefrontal cortex and limbic system, undergo long periods of developmental change and maturation, punctuated by periods of significant growth (Tottenham & Galván, 2016).

The prefrontal cortex begins to develop at birth and remains dynamic until young adulthood; however, there are several periods of dramatic prefrontal development in infancy (0-1), middle childhood (3-6), and adolescence (starting at approximately age 11). Infants develop the capacity to engage in tasks that require nascent executive functions such as working memory and response inhibition, demonstrating emerging capacities for self-control (Espy, Kaufmann, McDiarmid, & Glisky, 1999; Garon, Bryson, & Smith, 2008). During childhood, tasks that require combinations of executive functions such as working memory and response inhibition become possible. This allows children to take other's perspective, develop empathy, and engage in social tasks that require delayed gratification. Finally, synaptogenesis, myelination, and gray matter reductions occur simultaneously across adolescence and into early adulthood, during which time more nuanced executive functions are developed (Diamond, 2002).

Similar to prefrontal cortices, the limbic system is also undergoing a period of growth and maturation during childhood (Casey, Jones, & Hare, 2008). Limbic regions are associated with emotional memory and self-regulation (Ahmed, Bittencourt-Hewitt, & Sebastian, 2015). Adaptive development of these systems allows for normative functioning in all of these domains, whereas abnormal development can lead to altered

regional brain volumes and over or under-responsiveness to situational stimuli in areas such as memory, emotional response, and sensory processing (Tottenham & Sheridan, 2010).

Experience-dependent maturation in self-regulatory areas. Schore argues that the earliest stage of right brain development – predominantly in prefrontal and limbic areas – is experience-dependent (1996). Specifically, the maturation of these centers for self-regulation, emotion, and memory related to internal working models must be fostered by responsive and consistent parent-child interactions. During attuned interactions, mother's eye contact, voice tone, mirroring of child actions, facial affect, and posture spur the release of neurochemicals such as dopamine in both parent and child, and concurrently create neurological connections in prefrontal and limbic regions. Through repeated, positive interactions, infants with parents who foster secure attachments come to develop adaptive, neurologically based patterns of responding, which underlie the child's internal working model of their parent. The internal working model, in Schore's theory, is a pattern of neurological and neurochemical responding ingrained in the child through repeated attuned interactions, which generalizes beyond the parent-child relationship after years of parent-child interaction (Schore, 2001, 2017). The securely attached child's brain is programed through these interactions to respond in a well-regulated, positively emotionally valenced way to future social interactions due to their pattern of early experiences.

Schore's model gives brief reference to adolescent's prefrontal development. He postulates that attachment relationships, and the growth patterns they support, may be necessary as individuals grow through the adolescent 'spurt' of prefrontal neurological

development. Thus, the importance of the parent-child attachment relationship may extend far beyond infancy, into important periods of rapid brain development across adolescence (Schore, 2001). Parents of teens may act in a similar role as parents during infancy, supporting adaptive neurological growth and connections. Furthermore, positive parent-child interaction may also be important during life-stage changes (for example, starting middle or high school or entering into a romantic relationship), when the child's ability to self-regulate is stressed. During these times, the parent may serve an important co-regulatory role, enhancing the child's ability to create a working model of the self as able to cope with environmental demands in a new and more complex life domain. Adolescence represents a unique overlap of prefrontal development and role change when attachment becomes particularly salient (Moretti & Peled, 2004).

Finally, Schore and other epigenetic researchers have argued that some degree of potential for neuronal growth in adolescence may be influenced by dyadic experiences as an infant. This experience dependent sensitive period may be due to genetic changes caused by neurochemical releases during dyadic interactions in early infancy (Schore, 1996, 2017). This would suggest that among children who had sub-optimal interactions in infancy, adolescence might be a less influential time period. However, neurological studies suggest that highly abnormal and deprived early environments are necessary to produce irreversible change to these brain regions indicating that these effects should not be found outside of highly traumatized or neglected populations, which the population of this study does not represent (Joseph, 1999; Perry, 2002).

Parent-adolescent attachment. Contemporary attachment theory has argued for attachment as an important developmental construct well into adolescence and adulthood.

Throughout adolescence, the role of the parent as a secure base from which the child can explore their environment safely becomes even more important. During adolescence developmental tasks are centered upon environmental and self-exploration, including individuation, autonomy, and self-identity exploration (Allen et al., 2003). These tasks demand considerable self-regulatory skill from the growing youth. In exploring their world and themselves with increasing autonomy, youth are required to utilize adaptive skills, navigate their social world, and take on developmental tasks, all drawing deeply on their self-regulatory reserves. Having a secure base to return to remains imperative in these stressful situations (Bowlby, 1988).

The changing nature of this relationship is highlighted by the use of shifting vocabulary across the age span. In adolescent-parent relationships, parental availability becomes more important than parental physical presence or immediate responsivity. That is, an adolescent should know that their parent is available to them when they need them to provide sensitive, attuned responses to their emotional and regulatory needs, as opposed to present during each of their daily activities (Duchesne, Ratelle, Poitras, & Drouin, 2009). Internal working models and 'scripts' of expected relational patterns are paramount, as an adolescent holds their concept of their parent as a supportive individual in their mind throughout interactions with others and with difficult daily tasks (Dykas, Woodhouse, Cassidy, & Waters, 2006). It follows that youth who must face the environmental and developmental challenges that the increased autonomy of adolescence brings, without the co-regulatory figure and positive regulatory experiences that a secure attachment affords, may be at a regulatory disadvantage; and subsequently, at increased risk for developing internalizing or externalizing problems.

Attachment security and internalizing and externalizing problems. Indeed, among studies investigating adolescent attachment, parent-adolescent attachment security has emerged as a significant protective factor from internalizing and externalizing problems (see McElhaney, Allen, Stephenson, & Hare, 2009 for review).

Regarding externalizing problems, parent-adolescent attachment security in the adolescent and pre-adolescent periods has been found to be protective against delinquency, school dropout, peer problems, risky sexual activity, and drug use (Allen et al., 2002; Allen, Moore, Kuperminc, & Bell, 1998; Barber, Olsen, & Shagle, 1994; Frank, Schettini, & Lower, 2002; Marsh, Mcfarland, Allen, Mcelhaney, & Land, 2003; Moretti & Peled, 2004). In fact, growth curve analyses show that while insecurely attached non-clinical youth show steady growth in externalizing problems over adolescence, youth with secure attachments show slight declines (Allen, Porter, McFarland, McElhaney, & Marsh, 2007). These findings occur in clinical and non-clinical samples, as well as across gender, socioeconomic status, and ethnic group (Dornbusch, Erickson, Laird, & Wong, 2001).

Regarding internalizing problems, parent-adolescent attachment security is protective against anxiety, negative self-esteem, depression, and disordered eating (Allen et al., 2007; Lee & Hankin, 2009; Moretti & Peled, 2004). Longitudinal studies across adolescence have supported insecure parent-adolescent attachment as a risk factor for increasing depression and anxiety across adolescence; whereas, secure parent-adolescent attachments predict declines in anxiety and withdrawal, even in the presence of trait risk (Jakobsen, Horwood, & Fergusson, 2012; Lee & Hankin, 2009). Recent meta-analyses have supported moderate effect sizes pointing to secure attachments as protective against

internalizing symptoms across childhood and into mid-adolescence (Brumariu & Kerns, 2010; Madigan, Brumariu, Villani, Atkinson, & Lyons-Ruth, 2016).

Several longitudinal studies have also investigated the effect of parent-child attachment security in infancy and childhood on protection from internalizing and externalizing problems in adolescence and early adulthood, finding consistently significant protective effects (Brumariu & Kerns, 2010; Burgess, Marshall, Rubin, & Fox, 2003; Lyons-Ruth, 1996; Madigan et al., 2016). These studies point out an important and nearly omnipresent confound of adolescent attachment research. Since infant and childhood attachment are also unique predictors of adolescent psychopathology, and children with secure attachment figures are more likely to become adolescents with secure attachment figures. Adolescent studies that do not control for childhood attachment security may not be measuring the unique impact of adolescent attachment, but instead measuring the longitudinal impact of a secure childhood attachment. Unfortunately, there are few longitudinal studies that follow children from infancy through adolescence that include measures relevant to these questions.

Studies investigating the mechanisms of the relationship between attachment and internalizing problems suggest difficulties in self-regulation - specifically emotion dysregulation - may increase risk for depression and anxiety problems (Kerns & Brumariu, 2014; Kobak, Sudler, & Gamble, 1991). Similarly, the behavioral regulation skills necessary to regulate anger and frustration and to control harmful behavioral impulses, have been proposed as a mediator between early secure attachments and externalizing problems (Guttmann-Steinmetz & Crowell, 2006). It has been suggested that parents who provide the consistency, structure, availability, and a cooperative

parenting style that fosters secure attachment, are also instilling these important

emotional and behavioral regulation skills in their children (Grolnick & Farkas, 2002).

Parent-child attachment security and self-regulation. While there are also few

studies empirically investigating the links between self-regulation and parent-adolescent

attachment specifically, the existing data shows that adolescents with secure attachments

show more effective emotion regulation and behavioral regulation, and that they may also

have better physiological self-regulation. Parent-adolescent attachment security supports

clearer emotional expression, emotional self-awareness, and less avoidance of their own

and others emotional responses, less interpersonal conflict, and higher verbal and

behavioral control (Kobak, Cole, Ferenz Gillies, Fleming, & Gamble, 1993; McElhaney,

Allen, Stephenson, & Hare, 2009; Moretti & Obsuth, 2009). Additionally, interventions

that improve parent adolescent attachment security have shown concurrent improvements

in adolescent self-regulation, and decreases in internalizing and externalizing problems

(Moretti, Obsuth, Craig, & Bartolo, 2015). Regarding physiological self-regulation,

parent-adolescent attachment security has been related to some indices of

parasympathetic activation, though only one study could be found directly assessing this

connection (Willemen, Goossens, Koot, & Schuengel, 2008)

Research investigating the link between attachment and self-regulation is more

robust across infancy and childhood. Within these early attachment relationship, parental

responsivity, availability, and emotional safety foster positive self-regulation skills within

the child (Grolnick & Farkas, 2002). In longitudinal studies, securely attached parent-

child relationships have been shown to play an important role in the development of

higher-order structures for self-regulation such as executive functions, and to foster better

emotional and behavioral self-regulation across infancy and into early adolescence (Bernier, Carlson, & Whipple, 2010; Vohs & Baumeister, 2016; Vondra, Shaw, Swearingen, Cohen, & Owens, 2001).

Despite these promising findings, most studies investigating emotional and behavioral self-regulation rely on parent-report of youth's regulation abilities. These reports are subject to rater-bias and are behaviorally driven. Therefore, these measures may partially conflate reports of internalizing and externalizing behaviors with reports of self-regulation. Physiological measures have been proposed as a way to ameliorate this problem.

Physiological Self-Regulation Capacity

As suggested previously, self-regulation may play an important mediating role in the relationship between attachment and internalizing and externalizing problems. Broadly, self-regulation is the process of making continual self-corrective internal adjustments to maintain direction towards a goal (Vohs & Baumeister, 2016). These internally made adjustments take place within and across affective, behavioral, and physiological self-regulatory systems as an individual is presented with environmental and internal stimuli. As discussed previously, internalizing problems are often associated with deficits in emotional self-regulation, and externalizing problems are often associated with deficits in emotional and behavioral self-regulation.

Underlying behavioral and emotional self-regulation may be an even more basic self-regulatory skill stemming from the attachment relationship: physiological self-regulation. Physiological self-regulation is hypothesized to underlie the development of nuanced self-regulation skills within behavioral, cognitive, and emotion-regulation

domains (Calkins, 2007, 2009). Thus, development of physiological patterns of self-regulation may be an important underlying protective factor from broad psychopathology across adolescence (Beauchaine, 2015).

Physiological self-regulation capacity refers to one's capacity for voluntary control over the activities of the central and peripheral nervous system. This capacity to modulate one's physiological arousal is supported by structural and functional development within the central and peripheral nervous systems across development. It is hypothesized that these differences in development in the central and peripheral nervous system, referred to as physiological self-regulation capacity, underlie core abilities in behavioral and emotional self-regulation (Vohs & Baumeister, 2016). Describing methods for indexing these differences in voluntary control over one's physiology has been the subject of much research across the last several decades. Peripheral cardiac indices have been of much interest since they offer the ability to index autonomic nervous system functioning in a non-invasive manner. Porges's Polyvagal theory was one of the first to describe the theory surrounding linking cardiac indices to the concept of physiological self-regulation capacity (Porges, 2001).

Polyvagal theory. Polyvagal theory hypothesizes that evolutionary changes to the autonomic nervous system, and specifically the vagus nerve, are responsible for the nuances of social and affective responding in humans (Porges, 2001). Among more primitive animals (ex. fish, amphibians), the sympathetic nervous system responds to stimuli without influence from higher-order structures. This takes the form of a freeze response in the most primitive animals, facilitated by the dorsal vagal complex. In more evolutionarily advanced species, it takes the form of a fight/flight response, facilitated by

the sympathetic nervous system. In mammals, a myelinated vagus held within the ventral vagal complex (VVC) allows for active inhibition of the sympathetic nervous system's response on the heart, providing the most active choice in sympathetic responding. Furthermore, the cortex, the hypothalamic-pituitary-adrenal axis, neurochemicals, and the immune system mediate the autonomic nervous system, allowing for an even greater range of behavioral responding (Porges, 2001).

According to Polyvagal theory, voluntary self-regulation can only take place because of the uniquely evolved ability of a myelinated vagus nerve to inhibit sympathetic signals to the heart. During moments of physiological self-regulation, the vagus nerve increases in tone, (fires more rapidly) thereby decreasing the firing of the sinoatrial node (the pacemaker of the heart). Porges has described this action of vagal nerve firing decreasing heart rate as putting a *vagal brake* on heart rate. The rapid decrease in heart rate caused by the *vagal brake* leads to rapid calming of the organism's physiology, and consequently allows for similar down-regulation of behavior, and affective state (Porges, 1996). Concurrently, components of the VVC associated with somatomotor functions in the face, ear, larynx, pharynx, and neck activate, preparing mammals to engage in their social environment through looking, listening, vocalizing, and ingesting. This concurrent activation of self-regulatory and social exploration functions combine to form what Porges coins the *social engagement system.* Polyvagal theory states that when faced with a challenge, mammals attempt to respond with a combination of their nuanced, higher order structures first (VVC activation, cortical activation, etc.). The joint activation of these structures allows for adaptive social behavior and group interaction. However, mammals fall back on more primitive

responses when they lack internal skills (ex. development of vagal tone) or resources (ex. depleted cortical control due to chronic stress) necessary to engage in higher order processing (Porges, 2001). Porges' Polyvagal theory (1996) suggests that the maturation and activation of the parasympathetic nervous system allows for nuanced self-regulatory, emotional, social, and motor activities; and, that indices of parasympathetic activation can measure one's capacity to behave adaptively in these nuanced domains.

Peripheral indices of vagal tone. As vagal tone has been hypothesized to influence directly one's active control over heart rate and consequential physiological arousal, measures of vagal tone have been hypothesized to index ability to physiologically self-regulate. Common physiological measurement methods for vagal tone include heart rate variability (HRV) and respiratory sinus arrhythmia (RSA) (Grossman & Taylor, 2007; Porges, 2001). Heart rate variability is a measure of the change in time interval between successive heartbeats on an electrocardiogram (Berntson et al., 1997). RSA also measures changes in beat-to-beat intervals, but does so across the cycle of breathing. Respiration influences heart rate through its impact on vagus nerve activity, slowing heart rate on expiration and increasing heart rate when more oxygen becomes available upon inspiration. The difference in peak-to-peak interval between periods of expiration and inspiration composes the RSA value (Beauchaine, 2001; Yasuma & Hayano, 2004). Thus, RSA is described as a quantification of vagal brake activation across the breathing cycle, and purported to be a clearer correlate of parasympathetic activation than HRV which does not include respiratory influences (Beauchaine, 2001, 2015). HRV and RSA are often used interchangeably in the literature, although this is a subject of debate.

Within the overarching concept of RSA, the method used to measure RSA is also important in determining what RSA indexes. RSA can be measured at both a resting or trait level and a reactive or state level. Resting RSA is linked to physiological self-regulation capacity; whereas, RSA reactivity is purported to index physiological self-regulation efforts in response to a stimulus (Alkon et al., 2003). This study will utilize resting RSA as an index of physiological self-regulation capacity.

Neurovisceral Integration theory. Thayer and colleagues have extended Polyvagal theory, emphasizing the importance of characterizing the neurological structures that underlie the relationship between indices of vagal tone and autonomic function (2009). Neurovisceral integration theory provides evidence that the neurological structures associated with self-regulation are largely held in the prefrontal cortex (PFC); and, that indices of vagal tone can be used as a marker of PFC function. This assertion is based on three primary and consistent findings: (1) neural pathways link the prefrontal cortex to the parasympathetic nervous system (PNS), (2) positive correlations have been found linking HRV and RSA and executive function, and (3) neuroimaging links HRV and RSA and prefrontal activity (Thayer, Hansen, Saus-Rose, & Johnsen, 2009).

This theory, indicating that RSA may index PFC function, is important to this study for several reasons. First, a large portion of the literature supporting this study links parent-child attachment to self-regulatory skills such as behavioral inhibition and emotional control that have been hypothesized to stem from PFC development. Secondly, this study asserts that the parent-adolescent attachment may be especially important due to adolescence being a sensitive period for PFC development; thus, utilizing a reliable peripheral index of PFC function becomes essential. The following sections will

elaborate on the evidence supporting the aforementioned three consistent findings linking RSA, HRV, and PFC function.

Neural pathways linking prefrontal cortex to parasympathetic nervous system. The central autonomic network is a collection of brain regions and spinal cord locations that work together to maintain homeostatic regulation in the face of internal or external of stimuli. Areas within the cortex include the prefrontal cortex, anterior cingulate cortex, insular cortex, amygdala, and hypothalamus. These areas modulate behavioral arousal, emotion, stress responding, and executive functions. Neural signals travel from these cortical structures to the periaqueductal gray and parabrachial nucleus within the midbrain. These areas are responsible for integrating autonomic nervous system function with arousal and pain and pleasure response. From the cortex, signals travel into the brainstem, influencing areas associated with respiratory rate, blood pressure, and other homeostatic systems. These areas include the ventrolateral medulla, nucleus of the solitary tract, and nucleus ambiguus. Signals terminate within the brainstem, resulting in parasympathetic suppression and sympathetic activation of heart rate (Benarroch, 2014; Thayer et al., 2009).

Positive correlations link indices of vagal tone and executive function. Several studies link heart rate variability to prefrontal cognitive (executive) functions. Among toddlers, baseline HRV are associated with executive functioning performance (Marcovitch et al., 2010). Among children, basal HRV is associated with working memory and processing speed tasks (Staton, El-Sheikh, & Buckhalt, 2009). Hansen and colleagues found that exercise-influenced differences in resting HRV were associated with faster reaction times and more correct responding to working memory and

continuous performance tasks among military members (Hansen, Johnsen, Sollers, Stenvik, & Thayer, 2004). Similar results have been found among a group of elderly individuals using a card-sorting test (Albinet, Boucard, Bouquet, & Audiffren, 2010). In a study that split individuals into low and high HRV groups, results indicated that those with higher HRV showed faster response times and more correct responses (Hansen, Johnsen, & Thayer, 2003). This link has been found among those with panic disorder, indicating that this pathway holds promise in understanding clinical populations (Hovland et al., 2012).

Neuroimaging links indices of vagal tone and prefrontal activity. A meta-analysis published by Buchanan and colleagues chronicles the recent volume of literature linking HRV, to prefrontal activity through cerebral blood flow imaging and lesion studies (Buchanan et al., 2010). Specifically, positron emission tomography and functional magnetic resonance imaging showed concurrent changes in task-evoked HRV and neuronal activity in prefrontal regions (Allen, Jennings, Gianaros, Thayer, & Manuck, 2015). This meta-analysis also provides support for a neural pathway linking the PFC to HRV, demonstrating cerebral blood flow differences in the amygdala as well as the ventromedial prefrontal cortex (Thayer, Ahs, Fredrikson, Sollers, & Wager, 2012).

RSA may be an index of prefrontal activity. As described above, resting RSA is a quantification of HRV that takes into account the vagally mediated changes in heart rate across the breathing cycle. Through measuring the magnitude of the variations in heart rate across inspiration and expiration, we can calculate a quantification of an individual's vagal tone, or the strength of firing of their vagus nerve. This myelinated vagus nerve carries messages from an extensive neural network originating in the PFC, and the

stronger the firing, we can hypothesize the greater the activity that is taking place in the PFC. Its origin in the PFC is important for several reasons, but most importantly, this region is responsible for conscious control over self-regulatory capacities. Taken together, well developed self-regulatory functions in the PFC should lead to greater resting vagal tone, as witnessed through higher resting RSA.

Supporting the association between resting RSA and self-regulation capacity, Beauchaine and colleagues have theorized that two levels of vulnerability influence maladaptive outcomes: traits, driven by early maturing subcortical regions (bottom-up), and developmentally advanced, volitional prefrontal control of reactivity (top-down). As described in neurovisceral integration theory, this top-down, prefrontal control is related, through an extensive neural network, to autonomic control over HRV (Beauchaine, 2015). In measuring resting RSA, we are provided a peripheral, noninvasive way to access information otherwise obtained through neuroimaging and other more intensive measures of prefrontal brain activity. In measuring prefrontal activity, we gain insight into an individual's development of executive function and self-regulation related capacities. In contrast to biologically based bottom-up traits, top-down self-regulatory processes are developed and socialized and thus emerge throughout late childhood and adolescence as prefrontal maturation takes place; thus, it is important to developmental psychopathology research to understand the developmental processes underlying prefrontally mediated self-regulation capacities (Beauchaine & Thayer, 2015).

Physiological self-regulatory capacity and internalizing and externalizing problems. High resting RSA is hypothesized to index a high capacity for physiological self-regulation. Physiological self-regulation has been linked to better broad self-

regulation skills such as emotional, behavioral, and cognitive regulation in stressful situations, lower risk for development of psychological disorders, and general expressions of emotionality and engagement with one's environment across adolescence and adulthood (Beauchaine & Thayer, 2015; Geisler, Vennewald, Kubiak, & Weber, 2010; Ramaekers, Ector, Demyttenaere, Rubens, & Werf, 1998). Conversely, deficits in physiological self-regulation capacity is purported to predict fewer self-regulation skills and the emergence of internalizing and externalizing behaviors in adolescents during middle and early high school (Beauchaine, 2012).

   Internalizing problems. Poor physiological self-regulation has been linked to more severe depression symptoms and clinical major depressive disorder in adolescents (Licht et al., 2008; Tonhajzerova et al., 2009). Poor physiological self-regulation capacity is also linked to specific depression symptoms including depressed mood and suicidal ideation and behavior (Rottenberg, Wilhelm, Gross, & Gotlib, 2002). Results are mixed within community populations of young adolescents. Some studies report null findings (Bosch, Riese, Ormel, Verhulst, & Oldehinkel, 2009). However, others indicate that physiological measures may differentiate children who are at high risk for depression, but who are not currently depressed, from those at low risk (Gentzler, Rottenberg, Kovacs, George, & Morey, 2012).

   Anxiety and physiological self-regulation are also consistently correlated. Physiological indices of self-regulation such as RSA significantly predict clinical and subclinical anxiety among youth (Wetter & El-Sheikh, 2012). While no studies examine RSA in clinical groups of anxious adolescents, RSA is lower among adults with an anxiety disorder than control groups (Friedman & Thayer, 1998; Thayer, Friedman, &

Borkovec, 1996). These results hold with subclinical and trait-level measures of anxiety (Watkins, Grossman, Krishnan, & Sherwood, 1998). In an anxiety intervention study of adults, higher physiological self-regulation capacity across treatment was correlated with treatment responsiveness, and decreased anxiety symptoms (Mathewson et al., 2013).

The relationship between physiological self-regulation and somatic symptoms is infrequently studied, but points to a negative relationship. In pre-adolescents, studies have found that somatic symptoms that commonly co-occur with internalizing problems were higher in the presence of poorer physiological self-regulation capacity (Dietrich et al., 2011). These results were especially high in the context of high stress groups (Bosch, Riese, Dietrich, et al., 2009).

Externalizing problems. Aggressive behavior problems are consistently linked with lower physiological self-regulation capacity (Beauchaine, Gatzke-Kopp, & Mead, 2007). These results have been found among community samples of youth, such that lower resting RSA is generally predictive of more aggressive behavior over late childhood and early adolescence (El-Sheikh & Hinnant, 2011). Furthermore, some studies indicate that physiological self-regulation capacity, as indexed by RSA, may also differentiate between types and severity of aggression, with higher resting RSA predicting inclusion in low aggression or reactive aggression only groups, as opposed to proactive and mixed aggression groups (Scarpa, Haden, & Tanaka, 2010; Thomson & Centifanti, 2018). Finally, sex differences may be important in aggression and RSA among adolescents. Several studies show that males with higher aggression display lower physiological self-regulation capacity more often than females (Beauchaine, Hong, & Marsh, 2008; El-Sheikh & Hinnant, 2011).

Comorbidity. Comorbid internalizing and externalizing problems may be related to lower physiological self-regulation capacity than either symptom profile independently (Pang & Beauchaine, 2013).

The Current Study

Attachment and poor physiological self-regulatory capacity have been associated with internalizing and externalizing problems. Securely attached parent-child relationships allow adolescents to develop adaptive self-regulatory behaviors, schema of self-efficacy in self-regulation, and well-adapted physiological systems that support self-regulation. Over this time period, adolescents who achieve these developmental tasks shift from co-regulating with their parents, to having the ability to physiologically self-regulate in increasingly demanding situations. Despite the support for the relationship between attachment and self-regulation, and attachment and internalizing and externalizing problems, no study has integrated these concepts in an adolescent sample. The current study attempts to close this gap in the literature.

Hypotheses

Hypothesis 1. Adolescent attachment security, and parent attachment behaviors, will be negatively associated with internalizing and externalizing problems concurrently and prospectively.

Hypothesis 2. Adolescent attachment security, and parent attachment behaviors, will be positively associated with physiological self-regulation capacity concurrently.

Hypothesis 3. Physiological self-regulation capacity will be negatively associated with internalizing and externalizing problems concurrently and prospectively.

Hypothesis 4. Physiological self-regulation capacity will mediate the relationship

between adolescent attachment security and parent attachment behaviors and

internalizing and externalizing problems concurrently and prospectively.
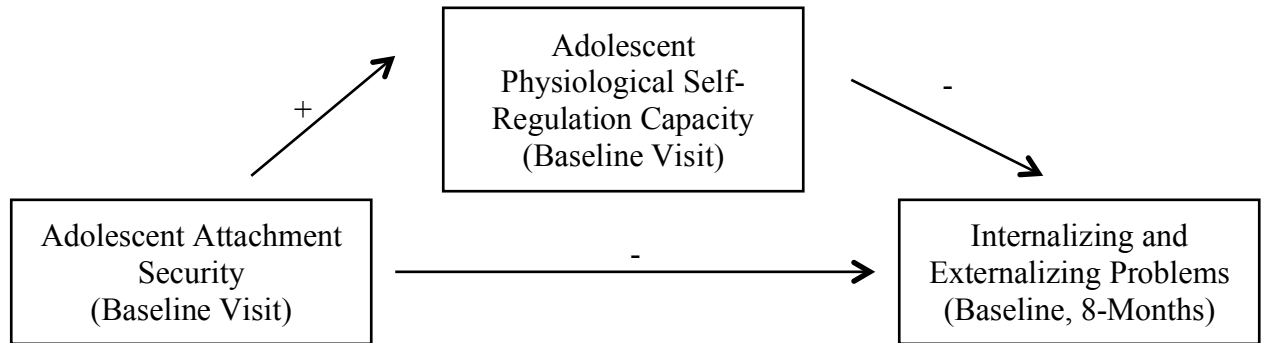

Figure 1. Proposed mediation model of the indirect effect of attachment security on
internalizing and externalizing problems through physiological self-regulation capacity.
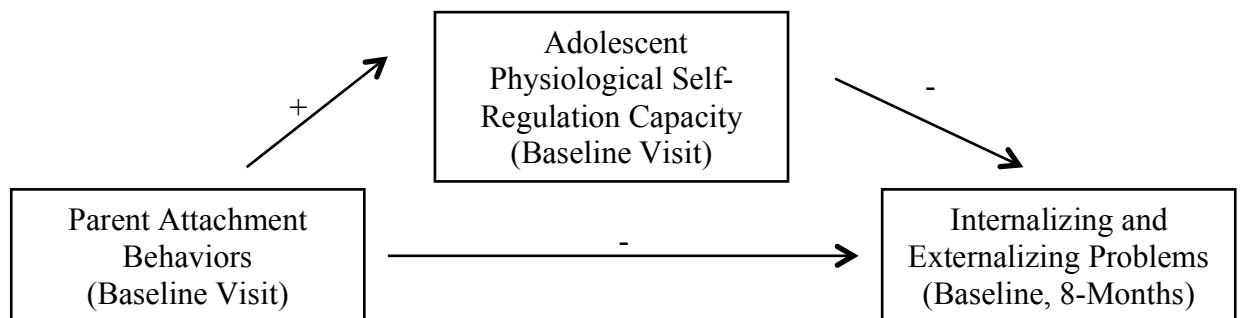

Figure 2. Proposed mediation model of the indirect effect of parent attachment behaviors
on internalizing and externalizing problems through physiological self-regulation
capacity.

CHAPTER II

Method

Sample and Participant Selection

      Participants. This longitudinal study was conducted through a participant pool involved in an ongoing investigation of the links between temperamental affect, self-regulation, and depression. Participants were 150 adolescents and parents. Adolescents were recruited from urban, public middle schools in the Pacific Northwest. Approximately 60.7% identified as Caucasian, 6.7% Asian, 0.7% African American, 0.7% American Indian or Alaskan Native, and 6.0% multiracial. The remaining participants chose not to respond. Approximately 2% of participants identified as Hispanic. The average age at baseline was 13.0 years, and 51.3% of the sample was female.

      Regarding the parents providing behavioral and relational data for their children, 76.7% were biological mothers, 19.3% were biological fathers, 1.3% were stepmothers, 1.3% were stepfathers, and 1.3% were legal guardians. Approximately 83.2% of caregivers identified as Caucasian, 7.1% Asian, 4.1% African American, and 2% multiracial. The remaining participants chose not to respond. Approximately 4% of the caregivers identified as Hispanic. Regarding marital status, 75.2% of caregivers reported being married, 22.1% divorced or separated, and 1.4% widowed. Remaining participants chose not to respond. Average yearly household income was above $150,000 for 53.6% of the sample, 36.6% between $75-150,000, 6.3% between $30-75,000, and 2.7% below $30,000.

Fritz and MacKinnon (2007) provide guidelines for sample size necessary to detect effects in mediation analyses. Their model indicates sample size based off of test type and effect size of the α and β paths. Results of a literature search indicated few studies that reported effect sizes for the role of attachment security in self-regulation capacity; however, among those studies, a medium (f=.26) effect size could be expected (Burgess et al., 2003). The effects sizes of self-regulation capacity on internalizing and externalizing ranged from small (η^2 = .004 - .013) to large (r^2 = .36); however, meta-analyses indicated moderate effect sizes (Dietrich et al., 2007; Koenig, Kemp, Beauchaine, Thayer, & Kaess, 2016). Recommended sample size for bias-corrected bootstrap models with medium effect sizes for the α and β and a power of .80 is 71 (Fritz & MacKinnon, 2007). Accordingly, the current study was deemed sufficiently powered with a sample size of 150 for the first lab visit, and 114 completing the eight-month follow-up visit.

Recruitment. Adolescents were recruited via in-class presentations at their middle schools. Electronic and printed flyers were used to contact and recruit parents. Interested parents contacted the study via post-card or online form.

Procedure

Enrollment. Interested youth and their families were screened for eligibility through a phone call. Parents were interviewed regarding several eligibility criteria. Due to impacts on RSA data, eligible adolescents must not have been taking a stimulant medication within 36 hours of their laboratory visit. Parents of adolescents on stimulant medication were asked if their child could take a 36-hour 'medication vacation', and families unable to do so were ineligible. Children also needed to be able to read English

and sit relatively still and answer questions for periods of at least 30 minutes. Parents of youth with learning or attention problems were queried regarding their child's ability level, and study staff and parents made determination of appropriateness for the study jointly.

Lab visit (baseline). Eligible adolescents and parents came to the university for a laboratory visit. Parents provided consent and youth assent before the visit. During this visit parents and adolescents reported on attachment security, parents reported on their children's internalizing and externalizing problems, and youth had resting physiological self-regulation capacity measured. Physiological self-regulation capacity was measured through collection of resting heart rate using electrocardiogram (ECG). Adolescents completed questionnaires and then were hooked-up to recording equipment for the collection of ECG data. Resting heart rate was collected as adolescents watched nature scenes on a computer screen for a period of four minutes. Youth were paid $35 and parents $50 for participation in the first lab visit, which took up to four hours.

Follow up visit (8-months). The follow-up lab visit occurred eight-months after the baseline visit. At these visits parents reported on their child's internalizing and externalizing problems in the four-month interval before the visit. Although families also completed a four-month follow-up visit, longitudinal analyses utilized data from the eight-month follow up visit to provide the longest prospective interval.

Measures

Demographic variables. Demographic variables including date of birth, sex, race, and ethnicity were collected at the first lab visit. Adolescent age was calculated for each participant at the time of baseline, and each follow-up visit.

Internalizing and externalizing problems. Adolescent internalizing and externalizing were measured with the Internalizing Problems and Externalizing Problems super-scales if the Child Behavior Checklist (CBCL; Achenbach & Rescorla, 2001). The items on these super scales make up 63 of the 118 items on the CBCL. The Internalizing Problems score is composed of Anxious/Depressed (13 items; e.g., "Cries a lot"), Withdrawn (8 items; e.g., "Would rather be alone than with others"), and Somatic Complaints (10 items; e.g., "Nausea, feels sick") subscales. Externalizing problems comprises the Aggressive Behavior (17 items; e.g., "Argues a lot") and Rule Breaking (15 items; e.g., "Lacks guilt") scales. Parents were asked to rate their children's behaviors on a 3-point Likert scale, from 0 (*not true*) to 3 (*very true or often true*). Total problems for each super-scale were computed as an average across relevant items. Higher scores indicated greater problems. In the literature, internal reliability of the Internalizing problems scale is .94, and of the Externalizing problems scale is .94. In the current study, internal reliability of the Internalizing problems scale was .88, and of the Externalizing problems scale was .83. Validity data is also strong. The CBCL correctly detects approximately 87% of clinical children as significantly elevated on total problems. The internalizing and externalizing scales correlate (r= .80-.88) highly with other strong measures of these groupings of problems (Achenbach & Rescorla, 2001).

Attachment security. Attachment security was assessed through adolescent and parent report measures. Adolescents used the Kerns Security Scale (Kerns, Klepac, & Cole, 1996), while parents used 10 items from the Child Rearing Practices Report (Kerns, Aspelmeier, Gentzler, & Grabill, 2001).

Adolescents reported on the security of their attachment to their parental figure (mostly biological mothers) using the Kerns Security Scale. This measure is specially designed to assess child perceptions of security in parent-child relationships in late childhood through early adolescence. Adolescents are presented with 15 paired statements such as 'Some kids think their [mom/dad] does not listen to them BUT Other kids do think their [mom/dad] listens to them.' Adolescents responded as to which statement was truer for them, and then indicated if their chosen item is *really true* or *sort of true* for them. Scores for each item represent a combination of chosen response and intensity of trueness. Final item scores range from 1 to 4. Higher scores indicate a more secure attachment. Total scores for the Security Scale were calculated as an average across all items (Kerns, Aspelmeier, Gentzler, & Grabill, 2001). Internal reliability for the Security Scale falls between .84 and .88 in the literature (Kerns, Klepac, & Cole, 1996). Internal reliability in our sample was .88. Scores on the Security Scale are significantly related to observational and interview measures of attachment (Granot & Mayseless, 2001).

Kerns 1996 study of attachment in adolescence was used as a model for parental report of attachment security (Kerns et al., 1996). Within Kern's study, parents reported on their tendency to engage in behaviors that support a secure attachment with their adolescent children (i.e., availability, autonomy support, emotional responsivity). Parents reported on these behaviors using 10 items of the Block's Child Rearing Practices Report (CRPR; Block, 1980). The 10-item block includes items such as 'I encourage my child to talk about their troubles' and 'I am easygoing and relaxed with my child.' Parents responded to each item according to degree of agreement on a 7-point Likert scale from

strongly disagree (1) to *strongly agree (7)*. Scores were calculated as an average of all items, with higher scores indicating behaviors supporting a stronger attachment, and more acceptance of and availability for their child. Within the literature alphas for the 10-item cluster in parents of early adolescents fall between .73 and .75, in the current study the scale had an internal consistency of .71. Parent report of their attachment behaviors were significantly correlated with child report of attachment security (Kerns et al., 1996).

Physiological self-regulatory capacity. Physiological self-regulation capacity was measured using basal RSA, a quantification of beat-to-beat intervals of ECG data. All participants had their ECG recorded in a sound and heat attenuated research suite. Participants were asked to hydrate and refrain from caffeine and stimulant medication in the 36 hours prior to their laboratory visit. Cardiac activity was collected during a four-minute 'vanilla' baseline, during which adolescents were seated at a computer and viewed nature images. 'Vanilla; baselines have been used to decrease risk for boredom and frustration related stress responses, which often occur among youth completing resting physiological measurements in which they are required to sit motionless and focus on a blank wall or computer screen (Jennings, Kamarck, Stewart, Eddy, & Johnson, 1992). Electrodes were configured in a Lead II configuration. In this configuration, pre-gelled Ag/AgCl electrodes are placed on the youth's left lower ribcage and below the right collarbone. ECG data was continuously collected using Biopac MP150 Data Acquisition System, sampling at 1000Hz. AcqKnowledge 4.1 software was used to collect signals, and data were analyzed using Mindware HRV 3.0.10 software. Each participant's data was visually inspected for accurate placement of r-peak markers. To ensure consistency, a single researcher corrected r-peak markers that were incorrectly

placed due to software error, movement, or other interference. Where significant distortion of physiological data was present for a short period of an epoch, the average peak-to-peak interval for the remainder of the epoch was used to approximate appropriate r-peak marker placement within the distorted time period. RSA values were computed across 30-second epochs, by subjecting the inter-beat interval time series to a Fast Fourier transformation. RSA values from all eight epochs across the vanilla baseline were averaged to compute a mean resting RSA score. A participant's physiological data was not used in analyses if four or more epochs of data were unusable (i.e., not able to be scored based on best practices).

Data Analytic Plan

Child and parent rated attachment security were examined in independent mediation models with internalizing problems and externalizing problems also run separately. This yielded four separate models run for cross sectional data, and four models for longitudinal data, yielding a total of eight separate mediation models. Data were analyzed using SPSS version 25. Stepwise regression was used to establish the *a*, *b*, and *c* paths of the conceptual mediation model. Preacher and Hayes PROCESS macro for SPSS was used to test the significance of the full mediation model (Preacher, Rucker, & Hayes, 2007). This macro uses logistic regression to calculate indirect effects and bootstrapping to estimate confidence intervals. The mediation models presented in Figures 3 and 4 were tested using PROCESS mediation model 4. The potential role of sex, age, ethnicity, and race were tested and these variables were controlled for as appropriate.

CHAPTER III

Results

Data Preparation Prior to Analysis

Prior to analysis, data were screened for appropriate range and outliers, conformation to the assumption of normality, and for patterns of missingness.

Outliers. First, data were screened to ensure all values were valid given Likert response ranges for questionnaire data; or, in the case of physiological data, that values were plausible given typical RSA values from community samples of comparable age (see Zisner & Beauchaine, 2016). For early adolescents, resting RSA values of 3-10 are generally considered appropriate and valid. Values under 3.5 and over 9 were inspected for validity by reviewing raw data from each epoch. All resting RSA values were valid and usable, falling between 3 and 10 and derived from valid epochs.

Missing Data. Missing data were most often the result of participants failing to attend a follow-up visit. Overall, 150 participants had valid data for the baseline visit and 114 participants had valid data for the eight-month follow-up.

Missing data were analyzed across raw data for all variables, for all participants who had completed the CBCL at the eight-month visit. In these 114 participants, 1.09% of values, 65.79% of cases, and 54.67% of variables had missing data. Little's chi-square test was consistent with the assumption that data were missing completely at random (p=1.00). Missing data were imputed at an item level for the Kerns Security Scale, the Block Child Rearing Practices Report, resting RSA, and CBCLs at baseline and eight-month visits. Data were not imputed for individuals who did not complete a time point.

Means, standard deviations, and range were compared across the original data and imputed data, with no significant differences found across data sets.

Normality. Normality was assessed through investigation of skewness and kurtosis in all study variables. Skewness and kurtosis statistics were z-scored to assess significance of deviation from normality, with values further from zero in either direction representing greater deviations from normality. This method enables comparison of skew and kurtosis values across measures, which is difficult with unstandardized skewness and kurtosis (Field, 2013). All variables except for resting RSA significantly deviated from a normal distribution (see Table 1). This deviation from normality was addressed through using bootstrapping procedures to control for Type 1 error without imposing an assumption of normality on the data (Preacher & Hayes, 2008).

Table 1
Skew and Kurtosis for Continuous Variables

	Skewness	z-scored Skewness	Kurtosis	z-scored Kurtosis
Child-Rated Attachment (KSS)	-1.33	-6.71***	1.32	3.36***
Parent Attachment Behaviors (CRPR)	-.76	-3.81***	.26	.67
Resting RSA baseline	-.16	-.78	.46	1.16
CBCL Internalizing (baseline)	1.18	5.95***	1.82	4.63***
CBCL Externalizing (baseline)	1.92	9.70***	6.46	16.39***
CBCL Internalizing (8-months)	1.75	7.73***	3.65	8.14***
CBCL Externalizing (8-months)	1.59	7.05***	2.62	5.84***

Note. For z-scored normality statistics, absolute values greater than 1.96 are significant at $p<.05$ (*), above 2.58 are significant at $p<.01$ (**), and values above 3.29 are significant at $p<.001$ (***). Baseline measure N=150, 8-month measure N=114.

Descriptive Statistics

Demographic variables. Mean and standard deviation for demographic variables and study variables are presented in Table 2, and fell within expected values. Bivariate correlations between demographics and study variables are presented in Table 3. Resting

RSA at baseline and gender were significantly correlated. No other demographic variables were consistently and significantly associated with study variables. Gender was included as a covariate in all analyses including baseline RSA as a variable. Bivariate correlations between study variables are presented in Table 4.

Table 2
Descriptive Statistics for Demographic and Study Variables

	N	M (SD)
Gender (0 = male, 1 = female)	150	.51(.50)
Age	148	13.04(.90)
Race	111	--
Hispanic (2=no, 1=yes)	111	1.97(.16)
Child-Rated Attachment (KSS)	150	3.41(.52)
Parent Attachment Behaviors (CRPR)	150	6.15(.58)
Resting RSA (baseline)	150	6.10(1.01)
CBCL Internalizing (baseline)	150	7.71(6.16)
CBCL Externalizing (baseline)	150	5.63(5.24)
CBCL Internalizing (8-months)	114	6.62(6.42)
CBCL Externalizing (8-months)	114	4.08(4.31)

Table 3
Bivariate Correlations among Demographic Variables and Study Variables

	1	2
1. Gender (0 = male, 1 = female)		
2. Age	.03	
3. Child-Rated Attachment (KSS)	-.12	-.16
4. Parent Attachment Behaviors (CRPR)	.04	-.10
5. Resting RSA (baseline)	-.21**	-.04
6. CBCL Internalizing (baseline)	.03	.07
7. CBCL Externalizing (baseline)	-.01	-.14
8 CBCL Internalizing (8-months)	.16	.10
9. CBCL Externalizing (8-months)	.15	-.03

Note. ** $p < .01$; * $p < .05$. Baseline measure N=150, 8-month measure N=114.

Study variables. Child-rated attachment security was significantly correlated with parent attachment behaviors, and with CBCL externalizing, but not internalizing, scores. Parent attachment behaviors were significantly correlated with all CBCL subscales at all time points and with resting RSA. Resting RSA was significantly

relationship between child-rated attachment security and concurrent internalizing problems was not independently significant (c path β = -1.15, p = 0.23), nor was child-rated attachment security and concurrent physiological self-regulation capacity (a path β = -.16, p = 0.28). Similarly, physiological self-regulation capacity was not associated with internalizing problems concurrently (b path β = .09, p = 0.86). The full model failed to reach significance (β = -.01, 95% CI [-.23, .23]).

When utilizing parent report measures, greater attachment security was related to lower concurrent internalizing problems (c path β = -3.38, p < .00). Attachment security was also significantly related to physiological self-regulatory capacity (a path β = -.31, p = 0.02), although in the opposite direction than expected. It was predicted that attachment security would relate to stronger physiological self-regulatory capacity, as opposed to weaker self-regulatory capacity. Physiological self-regulatory ability was not independently related to concurrent internalizing problems (b path β = -.23, p = 0.49). The full model failed to reach significance (β = -.07, 95% CI [-.23, .48]).

Taken together, parent report measures, but not child report measures yielded two significant findings. First, attachment security was related to lower concurrent internalizing problems. Second, and counter to hypotheses, attachment security was related to poorer concurrent physiological self-regulatory capacity. No other results were significant.

Longitudinal analyses. No portion of the longitudinal mediation model for child-rated attachment security and internalizing problems was significant. The direct effect of child-rated attachment security predicting internalizing problems over eight-months was non-significant (c path β = -1.78, p = 0.13). The concurrent relationship between child-

rated attachment security and physiological self-regulation capacity also remained non-significant in the smaller (N= 114) prospective sample (a path β = -.09, p = 0.61). Similarly, physiological self-regulation capacity did not predict internalizing problems over eight-months (b path β = -.21, p = 0.72). The full model failed to reach significance (β = .01, 95% CI [-.20, .36]).

Again, when utilizing parent report measures, attachment security was significantly related to lower internalizing problems (c path β = -4.34, p < .00) concurrently; but also to lower physiological self-regulatory capacity (a path β = -.32, p = 0.03) in the smaller prospective sample. Also mirroring cross-sectional results, physiological self-regulatory capacity was not related to internalizing problems eight-months prospectively (b path β = -.71, p = 0.22). The full model failed to reach significance (β = .23, 95% CI [-.13, .82]).

Thus, results of prospective analyses mirrored cross sectional findings. Parent report measures, but not child report measures, yielded the same two significant findings. First, attachment security predicted lower internalizing problems eight-months prospectively. Second, and counter to hypotheses, attachment security was related to poorer concurrent physiological self-regulatory capacity. No other results were significant.

Table 5

Results of Mediation Model for Child-Rated Attachment Security and Internalizing Problems

	Unstandardized B	SE	95% CI Lower	95% CI Upper	p
Cross Sectional – DV Internalizing at Baseline (N=150)					
KSS → RSA (a path)	-.16	.15	-.47	.14	.28
RSA → Internalizing (b path)	.09	.51	-.93	1.11	.86
KSS → Internalizing (c path)	-1.15	.96	-3.06	.75	.23
KSS → Internalizing (c' path)	-1.10	.98	-3.04	.83	.26
KSS → RSA → Internalizing	-.01	.10	-.23	.23	
Longitudinal – DV Internalizing at 8-Months (N=114)					
KSS → RSA (a path)	-.09	.18	-.44	.26	.61
RSA → Internalizing (b path)	-.21	.62	-1.46	1.02	.72
KSS → Internalizing (c path)	-1.78	1.19	-4.15	.58	.13
KSS → Internalizing (c' path)	-1.61	1.19	-3.99	.76	.18
KSS → RSA → Internalizing	.01	.12	-.20	.36	

Note. ** *p*< .01; * *p*< .05; ^Significant confidence interval

Table 6

Results of Mediation Model for Parent Attachment Behaviors and Internalizing Problems

	Unstandardized B	SE	95% CI Lower	95% CI Upper	p
Cross Sectional – DV Internalizing at Baseline (N=150)					
CRPR → RSA (a path)	-.31	.13	-.59	-.04^	.02*
RSA → Internalizing (b path)	-.23	.49	-1.22	.74	.63
CRPR → Internalizing (c path)	-3.38	.83	-5.02	-1.73	<.00**
CRPR → Internalizing (c' path)	-3.48	.85	-5.16	-1.79^	<.00**
CRPR → RSA → Internalizing	.07	.17	-.23	.48	
Longitudinal – DV Internalizing at 8-Months (N=114)					
CRPR → RSA (a path)	-.32	.15	-.63	-.01^	.03*
RSA → Internalizing (b path)	-.71	.58	-1.88	.45	.22
CRPR → Internalizing (c path)	-4.34	.98	-6.28	-2.40	<.00**
CRPR → Internalizing (c' path)	-4.59	.98	-6.54	-2.63	<.00**
CRPR → RSA → Internalizing	.23	.25	-.13	.82	

Note. ** *p*< .01; * *p*< .05; ^Significant confidence interval

Is the Relationship between Attachment Security and Externalizing

Problems Mediated by Physiological Self-Regulation Capacity?

Cross-sectional analyses. Greater child rated attachment security (c path *β* = -

2.59, *p*<.00) was significantly related to lower externalizing problems. However, results

for the remainder of the model did not align with hypotheses. Child-rated attachment security was not significantly related to physiological self-regulation capacity (a path $\beta =$ -.16, $p = 0.28$). Better physiological self-regulation capacity was significantly related to more, not fewer, concurrent externalizing problems (b path $\beta = 1.02$, $p = 0.01$). The full model failed to reach significance ($\beta = -.17$, 95% CI [-.68, .14]).

When utilizing parent report, greater attachment security was significantly related to lower concurrent externalizing problems (c path $\beta = -3.63$, $p < .00$). Unexpectedly, greater attachment security was also significantly related to lower physiological self-regulatory capacity (a path $\beta = -.31$, $p = 0.02$). The relationship between physiological self-regulatory capacity and concurrent externalizing problems was also significant, but also was in the opposite direction as expected theoretically (b path $\beta = .77$, $p = 0.05$). The full mediation model failed to reach significance, though results indicated a trend towards greater parent reported attachment behaviors predicting fewer externalizing problems concurrently, through attachment security's effect on physiological self-regulation capacity ($\beta = -.24$, 95% CI [-.80, .08]).

In summary, child and parent-rated attachment security was related to fewer externalizing problems concurrently. However, results for the remainder of the model ran counter to trends in the literature. Better physiological self-regulation capacity was significantly related to higher, not lower, concurrent externalizing problems. Both models failed to reach significance and would have been difficult to interpret theoretically.

Longitudinal analyses. Child-rated attachment security significantly predicted lower externalizing problems over eight-months (c path $\beta = -1.98$, $p = 0.01$). However, the concurrent relationship between child-rated attachment security and physiological

self-regulation capacity was no longer significant in the smaller (N=114) prospective sample (a path β = -.09, p = 0.61); and, physiological self-regulation capacity did not predict externalizing problems over eight-months (b path β = -.11, p = 0.77). The full model failed to reach significance (β = .01, 95% CI [-.13, .21]).

When utilizing parent report measures, stronger attachment security (c path β = -3.92, p < .00) significantly predicted fewer externalizing problems over eight-months. The relationship between attachment security and physiological self-regulatory capacity mirrored cross sectional analyses indicating that stronger attachment security was related to lower physiological self-regulation capacity (a path β = -.32, p = 0.03). The relationship between physiological self-regulatory capacity and externalizing behaviors was non-significant (b path β = -.55, p = 0.13). The full mediation model failed to reach significance, though it trended towards greater parent reported attachment security predicting lower externalizing problems, through physiological self-regulation capacity (β = .18, 95% CI [-.02, .57]).

Taken together, parent and child-reported attachment security predicted fewer externalizing problems over eight-months. However, parent-reported attachment security was also related to lower physiological self-regulation capacity, mirroring cross-sectional results. Additionally, though the full model including parent-report attachment security trended towards significance, it would have been difficult to interpret in light of the theory supporting this study and the current literature. No other results were significant.

Table 7
Results of Mediation Model for Child-Rated Attachment Security and Externalizing Problems

	Unstandardized B	SE	95% CI Lower	Upper	p
Cross Sectional – DV Externalizing at Baseline (N=150)					
KSS → RSA (a path)	-.16	.15	-.47	.14	.28
RSA → Externalizing (b path)	1.02	.41	.19	1.85^	.01*
KSS → Externalizing (c path)	-2.59	.79	-4.16	-1.01^	<.00**
KSS → Externalizing (c' path)	-2.46	.79	-4.02	-.89^	<.00**
KSS → RSA → Externalizing	-.17	.21	-.68	.14	
Longitudinal – DV Externalizing at 8-Months (N=114)					
KSS → RSA (a path)	-.09	.18	-.44	.26	.61
RSA → Externalizing (b path)	-.11	.41	-.93	.70	.77
KSS → Externalizing (c path)	-1.98	.78	-3.54	-.42^	.01*
KSS → Externalizing (c' path)	-1.88	.79	-3.45	-.31^	.01*
KSS → RSA → Externalizing	.01	.08	-.13	.21	

Note. ** *p*< .01; * *p*< .05; ^Significant confidence interval

Table 8
Results of Mediation Model for Parent Attachment Behaviors and Externalizing Problems

	Unstandardized B	SE	95% CI Lower	Upper	p
Cross Sectional – DV Externalizing at Baseline (N=150)					
CRPR → RSA (a path)	-.31	.13	-.59	-.04^	.02*
RSA → Externalizing (b path)	.77	.40	-.03	1.57	.05*
CRPR → Externalizing (c path)	-3.63	.68	-4.99	-2.28^	<.00**
CRPR → Externalizing (c' path)	-3.39	.69	-4.76	-2.02^	<.00**
CRPR → RSA → Externalizing	-.24	.23	-.80	.08	
Longitudinal – DV Externalizing at 8-Months (N=114)					
CRPR → RSA (a path)	-.32	.15	-.63	-.01^	.03*
RSA → Externalizing (b path)	-.55	.36	-1.27	.17	.13
CRPR → Externalizing (c path)	-3.92	.60	-5.13	-2.72	<.00**
CRPR → Externalizing (c' path)	-4.11	.61	-5.32	-2.90^	<.00**
CRPR → RSA → Externalizing	.18	.15	-.02	.57	

Note. ** *p*< .01; * *p*< .05; ^Significant confidence interval

Post-Hoc Analyses

Relatively few significant or interpretable findings emerged from the initial

analyses. However, a significant relationship was found between parent attachment

behaviors and internalizing and externalizing problems concurrently and prospectively.

The ability of parent attachment behaviors in adolescence to predict changes in

internalizing and externalizing behaviors over eight months was examined by regressing

parent attachment behaviors on externalizing and internalizing behavior at the eight-

month visit, while controlling for internalizing and externalizing behavior at the baseline

visit.

Parent attachment behaviors did predict change in externalizing symptoms over

eight months, such that greater attachment security predicted decreases in externalizing

problems (β = -1.61, 95% CI [-2.77, -.44]). This relationship was not significant for

internalizing problems (β = -1.19, 95% CI [-2.59, .19]), though it trended towards

significance.

Table 9
Post-Hoc Regression Analyses (N=114)

	Unstandardized B	SE	95% CI		p
			Lower	Upper	
CRPR → Internalizing 8-months, baseline controlled	-1.19	.70	-2.59	.19	.09
CRPR → Externalizing 8-months, baseline controlled	-1.61	.58	-2.77	-.44^	.007**

Note. ** *p* < .01; * *p* < .05; ^Significant confidence interval

CHAPTER IV

Discussion

While there is a robust literature supporting the relationship between parent-adolescent attachment security and psychopathology, relatively few studies have investigated mechanisms by which secure parent-adolescent attachment relationships are related to fewer internalizing and externalizing problems. Examining moderators of this relationship is important to understanding the enduring effect of parenting in adolescence; as well as to primary prevention efforts aimed at ameliorating the effects of insecure attachments. This study investigated physiological self-regulation capacity as a mechanism by which secure parent-adolescent relationships may lead to protection from psychopathology.

This study had four main hypotheses. First, in accordance with existing literature, this study hypothesized that parent-adolescent attachment security would be related to significantly fewer internalizing and externalizing problems concurrently and prospectively. Second, it was hypothesized that more secure parent-adolescent attachment relationships would be concurrently related to greater physiological self-regulation capacity. Research investigating this link is scarce in the literature, representing a significant need for empirical studies investigating this association. Third, also following a robust literature, this study hypothesized that physiological self-regulatory capacity would be related to fewer internalizing and externalizing problems concurrently and prospectively. Finally, a mediation model was proposed, linking parent-adolescent attachment security to psychopathology through the effect of attachment on an adolescent's physiological self-regulatory capacity.

Results supported only the already-well-substantiated link between parent-adolescent attachment security and internalizing and externalizing problems. This association was present concurrently and prospectively, especially when it was measured using parents' report of their own attachment behaviors (child attachment did not predict internalizing problems in any analyses). This relationship held when controlling for baseline externalizing problems in prospective analyses, indicating that higher levels of parental attachment behaviors at baseline predicted significant decreases in externalizing problems over the length of the study. This result is consistent with a study by Allen and colleagues that found secure parent-child attachments to be predictive of declining problems among externalizing adolescents (Allen et al., 2007).

Additionally, while none of the mediation models tested reached significance, the concurrent and prospective models examining physiological self-regulation capacity as a mediator of parent-reported attachment behaviors and externalizing problems showed trends towards significance. However, these models also contained several unexpected results related to physiological self-regulation capacity. As previously indicated, better parent-adolescent attachment security predicted less externalizing problems concurrently and eight-months prospectively. However, counter to hypotheses, attachment was also related to worse physiological self-regulation capacity across cross-sectional and longitudinal models. The relationship between physiological self-regulation and externalizing problems was also inconsistent with prior research, with better physiological self-regulation capacity predicting more externalizing problems in the concurrent model, and the relationship failing to reach significance in the longitudinal

model. Thus, it is difficult to interpret these trends toward mediation in light of their theoretical implications.

Limitations and Strengths

The relationship between physiological self-regulation capacity, as indexed by RSA, and internalizing and externalizing problems is very well supported in the literature (Beauchaine, 2001; Beauchaine, 2015). Thus, it was surprising to find non-significant relationships in this study, and even more surprising to discover a positive relationship between physiological self-regulation capacity and concurrent externalizing problems. One potential source of these unexpected findings may be the relatively low-risk nature of our sample. The majority of studies examining RSA and psychopathology examine the effects of RSA in the context of a sample impacted by a risk factor such as maladaptive parenting, trauma, or familial risk for psychopathology. Furthermore, some studies have found an absence of findings within community samples with an absence of risk factors (Bosch, Riese, Dietrich, et al., 2009; Bosch, Riese, Ormel, et al., 2009). While our study did examine the combined effect of resting RSA and attachment security, children in our sample were not considered 'at risk' from an attachment perspective. Thus, our findings may reflect a relatively lower impact of resting RSA on risk for subclinical symptoms when not combined with other chronic risk factors.

Another related source of unexpected findings may be the non-clinical nature of the sample. The current sample displayed relatively low scores on measures of internalizing and externalizing problems, which decreased from baseline to the follow up visit. Internalizing problems were especially low, which is intuitive, as internalizing problems tend to develop later in adolescence. It could be that this restricted range of

scores also restricted the ability of analyses to detect the relationship typically found between these variables. Finally, examining scores for RSA, scores within our sample fell within expected range for the adolescent age group, and demonstrated an appropriate mean and standard deviation given the literature. Thus, a clear explanation linking our data for physiological self-regulation capacity to these unexpected findings is unlikely.

Next, although little research has investigated the link between parent-adolescent attachment and adolescent self-regulation capacity, the current study's findings linking more secure attachments to lower self-regulation capacity were unexpected from a theoretical perspective. Counter to our findings, the existing literature points to parent-adolescent attachment as supportive of emotional, behavioral, and some forms of physiological self-regulation (Willemen et al., 2008). One potential problem in this data may be the use of resting RSA to index the physiological systems stemming from a secure parent-adolescent attachment. In Willemen's study, adolescent secure base behaviors were significantly related to changes in RSA, cardiac pre-ejection period, and heart rate across a stressor task, instead of to indices of resting vagal tone (2008). Indices measuring reactivity are more sensitive to an adolescent's ability to remain engaged with, and to regulate through environmental stressors (Gentzler, Santucci, Kovacs, & Fox, 2009; Suess, Porges, & Plude, 1994; Zisner & Beauchaine, 2016). The ability to autonomously identify stressful situations and deploy regulatory resources, including perhaps physiological regulatory resources, without direct parental assistance, is a chief outcome of a secure parent-adolescent attachment (Moretti & Peled, 2004). Thus, resting RSA, which measures capability, but not necessarily appropriate deployment of self-

regulatory resources, may be a less sensitive physiological measure of the impact of adolescent attachment, leading to non-significant and counter-intuitive findings.

Additionally, studies have found that autonomy support may be the single most important factor in the relationship between the parent-child attachment relationship and development of prefrontally mediated self-regulation capacity (Bernier et al., 2010). While our indices of parent-adolescent attachment security did measure parent support of their adolescent's autonomy, questionnaire length limited the extent to which parent support of autonomy was captured. Within parent report measures, two out of ten items inquired about parent autonomy support, while in the child questionnaire one out of fifteen items directly addresses autonomy. It may be that our indices of parent-adolescent attachment security did not measure autonomy support to the extent necessary to detect this essential component of parent-adolescent attachment security on physiological self-regulation capacity.

Finally, the theories supporting the proposed model implied a largely unidirectional effect of attachment behaviors on physiological self-regulation. While there is certainly support for these theories, they may also leave out an important interaction between child characteristics and parenting. Specifically, children with lower physiological regulation capacity during late childhood and early adolescence likely display behavioral sequela of poor self-regulation that prompt their parents to modify their parenting. Adaptive parenting responses may include increasing parenting behaviors supporting a secure attachment. Thus, it may be that responsive parents of children with low RSA may increase adaptive parenting, including attachment behaviors, to meet the needs of their children, resulting in more attachment behaviors in children with lower

RSA, and this unexpected effect. In this way, children with poorer physiological self-regulation capacity may be inadvertently eliciting more attachment behaviors (ex., making themselves more available and increasing monitoring or emotional support) from their parents. This may be especially likely among a relatively well functioning community sample, as is present in the current study.

Also unexpected were the general lack of findings when utilizing child-report measures of attachment security. Child reported attachment security was only related to externalizing problems and parent-report attachment security; while, non-significant relationships were found with internalizing problems across both time points, and with physiological-self regulation. These findings were unexpected, as other studies of non-clinical adolescents have found significant relationships between internalizing problems and parent-adolescent attachment security utilizing this scale, suggesting that item content is appropriate for detecting attachment-relevant protective factors from psychopathology (Natarajan, 2013). Additionally, other studies have found non-significant relationships between attachment and internalizing and externalizing problems when adolescents report on their relationship with their fathers versus their mothers (Williams & Kelly, 2005). Thus, this study examined the adolescent-mother relationship only.

Clinical Implications

This study adds to a large literature supporting parent-adolescent attachment security as an important protective factor against internalizing and externalizing problems in adolescence. This growing collection of data has great clinical significance, as it points to the enduring importance of parental availability, emotional sensitivity, and autonomy

support throughout the transition to adolescence. Within non-clinical samples, supporting these competencies in the parent-adolescent attachment relationship will serve as an important protective factor against psychopathology. Furthermore, the current study's finding that parent-adolescent attachment security predicted decreases in externalizing problems may point to the importance of secure parental attachments especially for youth who already display externalizing problems in late childhood.

Suggestions for Future Research

As discussed above, several alterations could be made to future research to bolster potential effectiveness. First, inclusion of a greater number of questions addressing parental autonomy support in parent and child measures of adolescent attachment may be useful in capturing the unique profile of adolescent attachment, especially in studies investigating indices of prefrontal control. Secondly, inclusion of indices of parasympathetic responding such as well as resting parasympathetic tone may be useful in detecting the contributions of adolescent attachment security to physiological self-regulation. Thirdly, this study was limited to an eight-month prospective design, which may have limited the ability to capture the impact of attachment and self-regulation on internalizing symptoms, which emerge to a greater degree in later adolescence. Finally, given this study's short term prospective design, it is difficult to confidently point to protection from psychopathology or improvements in self-regulation capacity as uniquely linked to the secure parent-adolescent attachment, and not continuing effects of a secure parent-child or infant attachment. That is, assuming that most children with strong parent-adolescent attachments have experienced continual parenting behaviors supporting secure attachment. Thus, the most effective studies examining this model would be longitudinal

studies spanning infancy through adolescence, which could control for infant and child attachment, and thus examine the unique effects of adolescent attachment on psychopathology and self-regulation. These studies may also be able to examine any compensatory changes in parenting that occur among adolescents with lower physiological self-regulation capacity.

Conclusions

In conclusion, this study supported an already robust literature finding a significant link between parent-adolescent attachment security and internalizing and externalizing problems. However, results failed to support many other components of the proposed mediation model. These findings support the enduring need for strong parent-child attachments across adolescence, and provide insight into changes that would support more effective research in the future.

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