“THE BOY WHO WOULD NOT GROW UP”:

MATURITY AND PHYSIOLOGICAL RESPONSES

OF JUVENILE OFFENDERS

by

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ABSTRACT

Developmental maturity is an important concept with serious legal repercussions for adolescent offenders (*Kent v. U.S.*, 1966; *Roper v. Simmons*, 2005). Recent research has emphasized the neurobiological correlates of adolescent behavior, but there is little understanding of the neurobiological underpinnings of maturity. The current study explored maturity in adolescent offenders using both physiological and psychological tests to assess emotional reactivity. Correlational and regression analyses were used to evaluate the relationship between a measure of heart rate (using vagal tone) and skin conductance and several self-report measures of maturity. Findings indicated that adolescent maturity is composed of several different constructs and some constructs appear to share neurobiological underpinnings. Specifically, emotional reactivity appears to be one construct of adolescent maturity composed of several sub-constructs that can be indexed using heart rate, skin conductance, and psychological tests. Legal and clinical implications are discussed.

LIST OF ABBREVIATIONS AND SYMBOLS

α	Cronbach's index of internal consistency
β	Beta
df	Degrees of freedom: number of values free to vary after certain restrictions have been placed on the data
F	Fisher's F ratio: A ration of two variances
M	Mean: the sum of a set of measurements divided by the number of measurements in the set
N	Sample size
p	Probability associated with the occurrence under the null hypothesis of a value as extreme as or more extreme than the observed value
r	Pearson product-moment correlation
R^2	The overall variance explained
SD	Standard deviation: measure of dispersion in a frequency distribution
μ	Micro
<	Less than
=	Equal to

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INTRODUCTION

The present state of the juvenile justice system is the result of several conceptual changes over the course of its development. At the close of the 19th century, adolescent offenders were treated as equals to their adult counterparts, and were consequently tried and punished according to adult offender laws. However, reformers worked to establish a juvenile court by the early 20th century that focused on promoting rehabilitation through informal procedures and indeterminate sentences. In the 1960s, youth advocates succeeded in changing the juvenile justice system once again, when the Supreme Court ruled that offenders in juvenile court have the right to an attorney and other protections received by adult criminal defendants (*In re Gault*, 1967). These changes were appropriate in terms of the juvenile justice system's founding belief, which was that youth lacked maturity and full criminal intent (Grisso, 2013). The rehabilitative goal of the juvenile justice system is in direct contrast to that of the adult criminal justice system, where the focus is on deterrence and retribution.

However, the rehabilitative theme of the juvenile justice system came under attack between the late 1980s and early 1990s, amid increases in violent adolescent crime (OJJDP, 2002). Public opinion that the system was too "soft" on adolescent offenders placed pressure on politicians, who, in response, created legislative changes to the juvenile courts. Changes included lowering the age of judicial transfer in several states, thus allowing criminal prosecution of youth 14 years old and younger; and the introduction of automatic transfer statutes, under which many youths can be transferred to adult court if they have been charged with either a general or specific offense, depending on their age. In addition, prosecutorial direct file was added as a mechanism in some states, where prosecutors could make the choice to file a particular charge in adult court.

At present, the juvenile justice system appears to encompass goals that focus on both deterrence/retribution and rehabilitation. Although adolescent crime is on a decline, juvenile court dispositions include more incarcerations and for longer periods. Furthermore, critics claim that there truly has never been an implementation of effective, comprehensive rehabilitative treatments in court legislation (e.g., Woolard, Fondacaro, & Slobogin, 2001). Yet, the legal system appears to have second thoughts about giving adolescent offenders “adult time for adult crime”. This is evident by the inclusion of reverse transfer mechanisms, and the United States Supreme Court decision to abolish the juvenile death penalty (*Roper v. Simmons*, 2005), which clearly emphasized the immaturity of adolescents and emphasized that as a class they were less culpable than adult criminals. Furthermore, the U.S. Supreme Court struck down mandatory life without parole sentences for juveniles in 2012 (*Miller v. Alabama*), ruling that children are constitutionally different from adults for sentencing purposes. According to the summary, *Roper v. Simmons* (2005) and *Graham v. Florida* (2010) set precedence in highlighting the “significant gaps” between juveniles and adults, including youth’s “'lack of maturity' and 'underdeveloped sense of responsibility’ leading to recklessness, impulsivity, and heedless risk-taking." (*Miller v. Alabama*, 567 U.S., 8; *Roper v. Simmons*, 543 U. S., 569).

Before these landmark decisions, however, lawmakers had already recognized in the 1960s that maturity of adolescent offenders should be considered in a young person’s transfer to adult court. As outlined in the court case *Kent v. U.S.* (1966), the juvenile court should consider the following criteria (among others) in deciding whether or not to transfer an adolescent offender to adult court: community protection, the seriousness and type of the current offense, the appeal of prosecuting the youth under one jurisdiction when co-defendants in the crime are adults, the sophistication and maturity of the youth, and prior contact with legal and mental health institutions. The current separation of the juvenile justice system from the adult justice system suggests that adolescents are less capable of

mature judgment than adults (and therefore less culpable), and that they are more amenable to treatment and rehabilitation than adults (Scott & Grisso, 1997). Like "Peter Pan", the fictional character created by author J.M. Barrie (1904), it appears as though adolescents are viewed as not quite "grown up", thus constituting the need for different treatment from adults. Whether or not adolescents are "choosing" to avoid growing up, like Peter Pan, appears irrelevant to the rehabilitative goal of the juvenile justice system. The literature suggests that both psychological and neurobiological processes underlie maturity in adolescents, indicating that perhaps the choice to grow up is not one an adolescent can make using total free will.

Maturity and offending

In considering maturity as a mitigating factor in adolescent offenders' criminal culpability, and as an important criterion in youth transfer proceedings, lawmakers have made it clear that the immaturity of adolescents may contribute to offending behavior. Outside the legal arena, it has only been recently that the empirical literature has attempted to clarify the relationship between adolescent offending and maturity (Fried & Reppucci, 2001; Grisso et al., 2003; Modecki, 2008; Woolard et al., 2001). One viewpoint considers delinquent behavior to be a normative component of adolescent development and delinquency is thought to cease naturally through maturation (Baumrind, 1987; Moffitt, 1993; Scott & Grisso, 1997). Moffitt (1993) expanded on this theory by proposing that there are two distinct groups of juveniles who demonstrate offending behavior: life-course persistent and adolescent-limited. This proposal is known as the "maturity gap thesis". The life-course persistent category describes individuals as engaging in various types of antisocial behaviors at every life stage, due to the interaction between a child's neuropsychological problems and his or her crimonogenic environments, and eventual development of a pathological personality (Moffitt, 1993). On the other hand, the adolescent-limited category includes a larger group of individuals who commit antisocial

behaviors solely during adolescence (Moffitt, 1993). The adolescent-limited trajectory then suggests that adolescent delinquency is an extreme form of normalness, due to a maturation process that encourages adolescents to adaptively demonstrate antisocial behavior (Moffitt, 1993). According to this thesis, delinquency does not persist past adolescence, and not all adolescents will be delinquent. Some hypothesized factors that protect against delinquent behavior include delayed puberty, access to roles that are respected by adults, environments that limit learning about delinquency, and personal characteristics (Moffitt, 1993).

Another framework has examined "psychosocial maturity" in adolescent offenders, which is defined as the challenges faced by youth as they develop into successful adults (Greenberger & Sorenson, 1974). According to several developmental theorists, psychosocial immaturity in adolescents typically presents as "misguided" judgment, or an inability to make decisions based on their own inclinations and principles (Reppucci, 1999; Scott, Reppucci, & Woolard, 1995; Steinberg & Cauffman, 1996). Cauffman and Steinberg (2000) expanded the concept of psychosocial maturity by suggesting that misguided judgment in youth stems from an interaction of cognitive and psychosocial factors that differentiate adolescents from adults. Cognitive differences refer to the various ways in which adolescents think, and psychosocial differences refers to the range of emotional and social capabilities of adolescents. Together, these differences have been coined "maturity of judgment": the complex process of decision-making and its susceptibility to several cognitive, emotional, and social factors (Cauffman & Steinberg, 2000).

Research has shown that adolescents can demonstrate a lack of "maturity of judgment" that is, a lack of responsibility, perspective, and temperance, when making decisions about risky or antisocial behavior as compared to adults (Cauffman & Steinberg, 2000). One investigation of the link between offending and maturity reported that, although there were no differences of maturity of judgment

between delinquent and non-delinquent youth, there were differences between high and low delinquency male youth (Modecki, 2008). Furthermore, results indicated that maturity of judgment predicted self-report delinquency beyond other contributions such as age and antisocial decision making (Modecki, 2008). However, this study had several limitations. For instance, the samples differed in ways that may not be controllable (those who have gained entrance into University and those who may not), and the sample delinquent group showed much more dispersion in grades than is typically seen in detention centers. In addition, there were potential measurement concerns including the lack of IQ measurement, and the use of hypothetical antisocial behavior as opposed to real-world decision making and conduct problems.

Another study reviewed maturity of judgment factors, specifically temporal perspective, peer influence, and risk perception (Fried & Reppucci, 2001). These researchers found that detained youth were more likely to think of the future-oriented consequences (i.e. take perspective) of engaging in acts of delinquency than non-detained youth, and also less likely to anticipate pressure from their friends than non-detained youth (Fried & Reppucci, 2001). Furthermore, there were some age-based effects for temporal perspective, peer influence, and risk perception, in which younger and older adolescents on a U-shaped age continuum displayed more mature levels of these factors than those in the middle of the continuum (Fried & Reppucci, 2001).

In addition, inadequate psychosocial development may actually increase an adolescent's risk for offending (Chung, Little, & Steinberg, 2005). Indeed, maturity factors have been found to impact anti-social decision making, including an adolescent's proclivity to sell and/or use illegal drugs, and commit minor delinquent acts (Barnes & Beaver, 2010; Cauffman & Steinburg, 2000; Little & Steinberg, 2006). Moreover, there are specific maturity variables linked to predicting delinquency; one study suggests "temperance" significantly predicts violent, non-violent, and total delinquent

behavior among boys (Cruise et al., 2008). In this study, “temperance” referred to the ability to control impulsivity and think before acting. However, it has been known for some time that impulsivity is linked to antisocial behavior and even violence.

Psychosocial immaturity factors have been further linked to an adolescent defendant’s competence to stand trial (Grisso et al., 2003). Results indicated that compared to young adults, younger adolescents recognized risks significantly less often (Grisso et al., 2003). It also appears that younger adolescents were less likely to expect that risks would occur or that risks would be serious, as opposed to their older counterparts. Adolescents under 14 were also significantly less likely than older adolescents and young adults to provide long-range future consequences in explaining their choices. The researchers concluded that juveniles aged 15 and younger are significantly more likely than older adolescents and young adults to be impaired in ways that compromise their ability to serve as competent defendants in a criminal proceeding (Grisso et al., 2003).

While the link between maturity and adolescent offending is receiving increased research attention and is becoming better understood with the potential connection between low levels of maturity and delinquency in the empirical literature, public opinion about the relationship and how this relationship might affect sentencing is less clear and shows mixed results. Specifically, one study found that respondents’ perception of adolescent maturity is negatively correlated with reported severity of recommended sentences (Cochran, Boots, & Heide, 2003), whereas another study found that immaturity did not significantly influence public preferences for sentencing adolescent homicide offenders (Applegate & Davis, 2006).

Although empirical interest has typically focused on “maturity of judgment” factors in adolescent offenders, some researchers have found that these characteristics may be better captured by the term “sophistication-maturity.” Sophistication-maturity has been identified by Ewing (1990) as

one of three core constructs relevant to the psychological assessment of adolescent offenders for transfer proceedings, as initially outlined under *Kent* criteria. Additionally, some believe that the hyphenated term reflects the two sides of maturity in youth that can reflect more complex delinquency and developmental maturity which would be indicative of less engagement in delinquency. Salekin and colleagues (2001) empirically examined the concept of developmental maturity via prototypical analytic studies with forensic clinicians and juvenile court judges with real world experience with young offenders. Through a series of factor analytic and confirmatory factor analytic studies, it was shown that developmental maturity was underpinned by the three factors of autonomy, cognitive abilities and emotion regulation. The three key factors further map reasonably well onto the Cauffman and Steinberg (2000) model for "maturity of judgment", providing further support for the validity of this model. More specifically, Autonomy in the Salekin (2004) model is similar to Responsibility of the Steinberg and Cauffman (1996) model. The Cognitive skills factor in the Salekin model also appears similar to the Perspective factor in the Steinberg and Cauffman (1996) model. Finally, Emotion Regulation in the Salekin (2004) model is similar to Temperance in the Steinberg and Cauffman (1996) delineation of maturity. This overlap is important given that one study (Cauffman & Steinberg, 2000) involved top-down analyses of the construct and the other study entailed an empirical, bottom up approach (Salekin, Rogers, & Ustad, 2001; Salekin, Yff, Neumann, Leistico, & Zalot, 2002).

Although limited, there is research examining sophistication-maturity and adolescent offending. One study reviewing the link between sophistication-maturity and young offenders found that this construct was associated with non-violent offenses, and was a significant predictor of transfer to adult court (Leistico & Salekin, 2003). Furthermore, a survey of judges (Brannen et al., 2006) found that sophistication-maturity (and dangerousness) of adolescent offenders significantly impacted

transfer decisions made by judges. Clinical psychologists have also weighed in on sophistication-maturity. One study found that clinical child psychologists' beliefs about maturity were in line with the beliefs encompassed by *Kent* criteria. According to some thinking on this topic, it might be more appropriate to transfer youth mature enough to understand the nature and consequences of their behavior to adult court (Grisso, 2013; Salekin et al., 2001).

If the focus is on sophistication, the argument has been that adolescent offenders are advancing (maturing) as are other non-delinquent adolescents, although with an added layer of criminological thinking. Moreover, this criminal sophistication is reflected in an internal locus of control, criminal sophistication (greater involvement in advanced criminality), premeditation of actions, and understanding of behavior norms. Evidence suggests that the latter two characteristics feature prominently in the psychological literature on maturity (Salekin et al., 2001; Steinberg & Cauffman, 1996). This degree of overlap in theory and empirical research findings for the developmental maturity construct is encouraging because as the construct is refined and utilized, it will likely be better able to forecast behavior (e.g., how well one can expect young people to perform in psychological therapy).

Using the construct of sophistication-maturity to define maturity in adolescent offenders poses some complications. Current measures of maturity, especially those intended for use in assessments of juvenile transfer to adult court proceedings, may not validly assess sophistication-maturity. According to Salekin and colleagues (2001), there is a lack of measurement technology for assessing this developmental maturity in general and a lack of assessment technology for assessing the construct in a legal context, and most conceptualizations of maturity include pro-social items that automatically limit their variability among adolescent offenders if the emphasis is on assessing sophistication. Part of the lack of production of measures in this area has been due to confusion regarding the construct. One way to consider maturity is that it is not inherently tied to either pro-social or antisocial behavior. Rather,

one may conceptualize individuals as having varying levels of maturity, who then use their higher order skills toward either pro-social or antisocial behavior. Thus, either youth are advancing and maturating with the only distinguishing lag in maturity having to do with morality or social values but not, for example, other cognitive factors like perspective taking. Even if youth are progressing along a antisocial line, one important theoretical point is that youth with higher levels of maturity may well be more amenable to treatment. These youth can marshal their greater cognitive skills, emotion regulation, and clearer identity skills to benefit from psychotherapy and reach their treatment goals (Salekin et al., 2001; Garfield, 1994; Taylor, Pham, Rivkin, & Armor, 1998). If they do not do so, their higher maturity may continue to aid with more sophisticated adolescent criminal conduct. Thus, it's a double edged sword, where individuals who demonstrate autonomy, initiative, industry, identity, and ego integrity may be at an advantage to achieve criminological success or smooth transitions and progress in psychotherapy (Salekin, Rogers, & Machin, 2001).

The physiology of maturity

Recently, researchers have advocated for a greater focus on neurobiological underpinnings of serious behavior problems. Patrick, Durbin, and Moser (2012) proposed that efforts concentrate on neurobehavioral trait constructs, that is, constructs that vary between individuals and are both neurobiologically and behaviorally based (Depue & Iacono, 1989). Using this concept, Patrick and colleagues (2012) furthered the understanding of antisocial behavior through the examination of inhibitory control and defensive reactivity. The researchers coined this "psychoneurometric approach" as "the systematic development of neurobiologically based trait measures using psychological (i.e., traditional psychometric phenotypes as referents" (Patrick et al., 2012, p. 1048). It is apparent that the understanding of individual differences in

maturity may also be advanced by highlighting the variations in physiological and psychological expressions of traits indicative of maturity.

Typically, studies have employed “paper and pen” psychological measures in order to understand the cognitive, social, and emotional processes involved in maturity. Increasing technological advancement in cognitive neuroscience and neuroimaging has now allowed researchers to understand maturity’s neurobiological underpinnings. Magnetic resonance imaging (MRI) has been particularly revolutionary in spatially and temporally mapping the human brain, and more recently, has been used to study the process of neuromaturation and its relationship to human behavior. Developmental theorists have long postulated that adolescence is a time of tremendous cognitive change, reflective in the maturation of cognitive abilities throughout and after puberty. MRI research has further demonstrated that adolescence is a period of continued brain growth and change, particularly within the pre-frontal cortex, an area that has been noted to have a late maturation even into young adulthood (Giedd et al., 1999; Lenroot & Giedd, 2006; Spear, 2000; Sowell, Delis, Stiles, & Jernigan, 2001; Sowell, Thompson, Holmes, Jernigan, & Toga, 2000). This area coordinates higher-order cognitive processes and executive functioning such as planning, physiological arousal, and impulse control. The pre-frontal cortex also has subcomponents that are linked to various behaviors. The dorsolateral pre-frontal cortex has an established relationship with cognitive control of behavioral responses (Petrides, 2000), due to this area’s connections with sensory association cortices and differing premotor and motor areas in the medial and lateral frontal lobes. Another cortical region, collectively termed the orbitomedial pre-frontal cortex (Blumer & Benson, 1975), is collectively composed of the ventromedial and orbitofrontal areas of the pre-frontal cortex. This component is directly linked to medial temporal limbic structures such as the amygdala and hippocampus, and has been tied to

the ability to anticipate affective consequences of behavior (Bechara, Damasio, Tranel, & Damasio, 1997; Wagar & Thagard, 2004) and regulate emotional reactivity and expression (Damasio, Tranel, & Damasio, 1990; Davidson, Putnam, & Larson, 2000).

Several of these higher-order processes and functions have been linked to facets of maturity in adolescents. However, research exploring this relationship is less than substantial, particularly with adolescent offenders. Existing research does suggest that brain maturation is related to improvements in conscious awareness of emotion as well as behavioral regulation (Bennett & Baird, 2006), which are considered factors in an adolescent's "maturity of judgment," or, an individual's ability to display autonomy/responsibility, cognitive skills/perspective, and emotion regulation/temperance when making decisions (Cauffman & Steinberg, 2000). Furthermore, other executive functions such as decision making, problem solving, and response inhibition have also been linked to maturity (Cauffman & Steinberg, 2000; Galambos, Barker, & Tilton-Weaver, 2003; Galambos, MacDonald, Naphtali, Cohen, & de Frias, 2005).

In terms of adolescent offenders, research on the pre-frontal cortex and its associated structures tends to focus on the relationship between executive functioning and anti-social or violent behavior (Blair, 2001; Davidson et al., 2000; Henry & Moffitt, 1997; Krakowski, 1997; Morgan & Lilienfeld, 2000; Raine, 1993; Raine & Buchsbaum, 1996; Yang & Raine, 2009). A meta-analysis of 39 studies revealed that there is indeed a significant relationship between antisocial behavior and executive functioning impairments (Morgan & Lilienfeld, 2000). The meta-analysis employed criteria to ensure that the studies involved used reasonably well-validated neuropsychological tests to measure executive functioning deficits. The results

included 19 studies involving adolescent offenders or adolescents with behavior problems such as conduct disorder (CD) (Morgan & Lilienfeld, 2000).

Another meta-analysis looked at 43 studies involving the use of frontal imaging techniques (e.g., MRI research), and although results indicated significantly reduced pre-frontal structure and function in antisocial individuals, most of the studies involved adult populations (Yang & Raine, 2009). Those studies focusing on youth and the link between pre-frontal brain disruptions and antisocial or offending behavior included samples of aggressive children with epilepsy (Juhász, Behen, Muzik, Chugani, & Chugani, 2001), youth with early-onset conduct disorder (Kruesi, Casanova, Mannheim, & Johnson-Bilder, 2004), adolescents with disruptive behavior disorder (Li, Mathews, Wang, Dunn, & Kronenberger, 2005), young and pre-adolescent boys with co-morbid conduct disorder and ADHD (Herpetz et al., 2001), children with psychopathic traits (Blair, 2006), and adolescents with conduct disorder (Stadler, Sterzer, Schmeck, Krebs, Kleinschmidt, & Poustka, 2006; Sterzer, Stadler, Krebs, Kleinschmidt, & Poustka, 2005).

Among the conclusions drawn regarding the link between executive functioning and adolescent maturity, and the link between executive functioning and adolescent offending, there remains a lack of information on the link between executive functioning and maturity in adolescent offenders. Additionally, in order to measure the pre-frontal-based executive functions associated with maturity, numerous studies have used neuropsychological assessments, either without or in combination with advanced technology such as MRI research. However, expensive and time-consuming MRI research tends to be used with small sample sizes, and it may be more economically efficient and productive to use other methods of measuring executive functions

indicative of maturity. One promising area of exploration is looking at executive functions through pre-frontal cortex ties with the autonomic nervous system (ANS).

Executive functions, particularly inhibitory control and defensive (fear) reactivity can be reliably examined through ANS processes. This is due to the fact that the central and autonomic nervous systems (ANS) are coupled in the regulation of stress responsivity (Berntson & Cacioppo, 2000; Saper, 2002). The ANS contains two components: the sympathetic nervous system (SNS) and parasympathetic nervous system (PNS). SNS activity leads to excitation of the palmer eccrine sweat glands, which in turn causes increased conductivity in the skin's surface.

Skin conductance is related to executive functions such as arousal regulation and stress responsivity (Damasio et al., 1990; Raine, Reynolds, & Sheard, 1991; Tranel & Damasio, 1994; Williams et al., 2000). Using measurements of skin conductance levels (SCL), Raine (1997) suggested that impairments in the pre-frontal cortex lead to psychophysiological abnormalities such as reduced orienting and arousal. Reduced autonomic arousal as measured by SCL has also been linked to increased stimulation-seeking, fearlessness, and disinhibition, executive functioning traits associated with maturity (Gatzke, Raine, Loeber, Stouthamer-Loeber, & Steinhauer, 2002; Fowles, Kochanska, & Murray, 2000; Raine, 1993; Scarpa, Raine, Venables, & Mednick, 1997; Raine, 2005; Shannon, Beauchaine, Brenner, Neuhaus, & Gatzke-Kopp, 2007; van Goozen & Fairchild, 2008; van Goozen et al., 2007).

With regard to the PNS, associations between this system and autonomic arousal has been reliably assessed using resting levels of respiratory sinus arrhythmia (RSA), which is the regular variability of heart rate caused by the influence of the vagus nerve on the sinoatrial node (Akselrod, Gordon, Snidman, Shannon, & Cohen, 1985; Beauchaine, 2001). Several studies have found links between RSA and child/ adolescent psychological disorders associated with emotion

dysregulation, such as depression, anxiety, self-injury, and disruptive behavior (Beauchaine et al., 2007; Crowell et al., 2005; Shannon et al., 2007; Silk, Steinberg, & Morris, 2003). Low levels of RSA have also been linked to aggression, while higher RSA levels relate to increased cognitive performance and emotion regulation capacity (Beauchaine, 2001; Eisenberg et al., 1995; El-Sheikh, Buckhalt, Keller, & Cummings, 2007; Gordis, Feres, Olezeski, Rabkin, & Trickett, 2010; Thayer & Lane, 2000; Staton, El-Sheikh, & Buckhalt, 2008). In a review of the literature, Raine (2002) concluded that heart rate is the best-replicated biological correlate of antisocial and aggressive behavior in children.

Vagal tone

Much of the research linking RSA levels to emotion and arousal regulation have referred to RSA as vagal tone, which is a biological process involving the activity of the vagus nerve. This 10th cranial nerve provides inhibitory input to the heart via the PNS and helps regulate metabolic output in response to environmental events. The vagus nerve generally inhibits heart activity, such that increased vagal tone slows heart rate, and decreased vagal tone speeds heart rate, independent of sympathetic activity (Porges, Doussard-Roosevelt, Portales, & Greenspan, 1996). RSA is mediated predominantly by fluctuations of vagal nerve traffic, therefore providing an acceptable, non-invasive measurement of vagal tone (Berntson et al., 1997; Grossman & Taylor, 2007; Yasuma & Hayano, 2004).

The vagal circuit of emotional and arousal regulation involves afferent feedback and communications among various levels of the nervous system including the cortex and amygdala (Porges, 1994). Vagal tone thus provides an index of regulatory processes associated with the cortex and amygdala, in that high vagal tone is associated with the ability to self-regulate, and low vagal tone is associated with poor self-regulation and behavioral inflexibility (Appelhans &

Luecken, 2006; Hastings et al., 2008; Lewis, Lamm, Segalowitz, Stieben, & Zelazo, 2006; Ochsner & Gross, 2008; Porges, 2007a; Thayer & Lane, 2000). Vagal regulation is typically assessed using two measures: vagal tone assessed during baseline conditions and delta vagal tone, which is the change in vagal tone after exposure to an attention-demanding or challenging situation (El-Sheikh, Harger, & Whitson, 2001).

Gaps in the literature

In consideration of the need for increased research examining neurobiological correlates of adolescent behavior, my thesis will explore the construct of maturity in adolescent offenders. Currently, there is a paucity of research looking at executive functioning and maturity in adolescent offenders. Existing studies tend to focus on one link in the relationship (i.e., solely reviewing the association between antisocial behavior and pre-frontal deficits), or use only neuropsychological tests to measure executive functioning. Many of these studies also tend to have a small sample size, likely due to restraints from using expensive and invasive neurological measurements such as MRI machines. There has also been a scarcity of information about the validity and reliability of commonly-used maturity measures, and little variation in those measurements used for empirical purposes. One study examined the validity, reliability and administrative ease of several psychological assessment scales designed to measure "mature coping," and concluded that various instruments would be necessary to achieve a full assessment of individual maturity (Soderstrom, Castellano, & Figaro, 2001).

Furthermore, research findings have been mixed regarding the relationship between maturity and adolescent offending, where lower levels of psychosocial maturity have been linked to increased self-report offending behavior (Barnes & Beaver, 2010; Cauffman & Steinburg, 2000; Little & Steinberg, 2006), yet other research has found no differences between adolescent

offenders and non-delinquent youth in psychosocial maturity (Modecki, 2008), although notably, this study had several significant limitations. Some research has also reported that detained youth displayed greater psychosocial maturity (specifically, ability to take perspective) than non-detained youth (Fried & Reppucci, 2001). These varied results may be explained by the concept of sophistication-maturity; it has been proposed that higher maturity may alternatively indicate more sophisticated criminal conduct due to increased levels of autonomy and initiative, among other skills (Salekin et al., 2001). Alternately, it may simply be that more research is needed on this topic in order to better understand developmental maturity.

It is clear that the relationship between maturity and adolescent offending is an important concept that requires further examination. Research on immature judgment suggests that psychosocial influences on adolescent decision processes results in reduced criminal responsibility (Cauffman and Steinberg, 2000; Scott et al., 1995; Steinberg & Cauffman, 1996), which further emphasizes the potential of serious legal consequences arising from misunderstanding the relationship between maturity and adolescent offending.

It is also important to understand the role maturity plays in treating antisocial and violent behavior in adolescents. Offenders likely experience inadequate opportunities for psychosocial development while in custody, which presents a significant barrier to their successful re-entry into society (Steinberg, Chung, & Little, 2004). Non-incarcerated peers have had the chance to develop the values, maturity, and independence necessary for their transition to adult roles and responsibilities, but these opportunities do not exist in custody (Altschuler, 2005). A greater understanding of the ways in which various concepts of maturity act as either protective or risk factors will aid development of both preventative and treatment programs targeting adolescent antisocial and violent behavior.

The investigation into the cognitive, social, emotional and physiological processes involved in maturity is an important first step in the direction of understanding maturity and adolescent offending. Future research will want to focus on more complicated brain processes involved in maturity and adolescent offending using sophisticated equipment such as MRI machines. However, the elements of basic physiological processes and their relationship to maturity still require additional exploration.

This project proposes to explore maturity in adolescent offenders using both physiological and psychological tests. Physical markers of maturity may be more reliable than self-report measurements of maturity, due to suggestions that physiological tests are better indicators of emotional regulation in that they are more sensitive, and less biased and uncensored in comparison to paper and pencil measures (Blascovich, Vanman, Mendes, & Dickerson, 2011). Additionally, although high correlations have been found between self-report measures of emotional regulation and physiological reactivity, these self-report measures have only been normed on adult samples according to the reviewed literature (Gratz & Roemer, 2004). Consistent with prior research, this study examined defensive ("emotional") reactivity as the neurobiological referent for maturity. Empirical research on neurobehavioral indexes of antisocial behavior has highlighted the importance of inhibitory control and emotional reactivity, due to their established relationship with antisocial behavior in different age groups, and evidence that these constructs can be examined physiologically, psychologically, and behaviorally (Patrick et al., 2012). Emotional reactivity is linked to ANS circuitry involving both the pre-frontal cortex and amygdala, and is considered an important contributor to behavior regulation and other indices of maturity (Cauffman & Steinberg, 2000; Cole, Usher, & Cargo, 1993; Galambos et al., 2003, Galambos et al., 2005; Pennington & Ozonoff, 1996; Raine, 1997).

Previous research has established links between emotional reactivity and various brain regions by examining responses to pleasant and/or unpleasant stimuli (Cahill et al., 1996; Irwin et al., 1996; Lane, Reiman, Ahern, Schwartz, & Davidson, 1997a; Lane et al., 1997b; Morris et al., 1996; Taylor et al., 1998; Whalen et al., 1998) auditory (Blood, Zatorre, Bermudez, & Evans, 1999; Royet et al., 2000), olfactory (Fulbright et al., 1998; Royet et al., 2000; Zald, Donndelinger, & Pardo, 1998a; Zald & Pardo, 1997), gustatory (Zald, Lee, Fluegel, & Pardo, 1998b), and somatosensory (Francis et al., 1999) stimuli. In particular, emotional responses to aversive sensory stimuli have been attributed to activation of the amygdala. This appears to be the case with aversive auditory stimuli (Zald & Pardo, 2002), which has also been shown to elicit physiological responses such as changes in cortisol, blood pressure, and heart rate (Stelmack, 1990; Holand, Girard, Laude, Meyer-Bisch, & Elghozi, 1999; Bradley & Lang, 2000). White noise is considered one such aversive auditory stimulus, which has been used with young children, adolescents, adults, and in research on psychopathy and other antisocial behavior (e.g., Fung et al., 2005; Hare, 1978; Justus & Finn, 2007; Ogloff & Wong, 1990; Wang, Baker, Gao, Raine, & Lozano, 2012).

Hypotheses

In consideration of the aforementioned evidence, emotional reactivity was studied in this project using an aversive stimulus (white noise burst) paradigm. Previous investigations into autonomic arousal also influenced this study's decision to measure emotional reactivity using vagal tone (as estimated by RSA levels) and skin conductance levels (SCL). The psychological or behavior-based referent for maturity will also be examined using rating scales designed to measure various constructs of maturity, such as impulse control and responsibility.

First, it was expected that those with low baseline RSA and SCL prior to the aversive stimuli (a signaled white noise burst) will correspondingly score lower on the psychological measures of maturity. Low baseline patterns should also predict lower maturity scores. This hypothesis is consistent with evidence that low baseline RSA and SCL patterns indicate poor emotion regulation (Beachaine, 2001; Raine, 2005). Second, it was anticipated that those with low RSA and SCL following the signaled noise burst (RSA and SCL reactivity) will demonstrate high emotional reactivity, and will also receive lower scores on the paper and pencil maturity measures. Higher reactivity patterns are also presumed to predict lower maturity scores on self-report maturity measures. This hypothesis is supported by research indicating increased vagal tone suppression (high RSA and SCL activity) during arousing situations reflects more adaptive regulation, and executive functioning such as sustained attention, cognitive processing, and organization of responding to stressful conditions (El-Sheikh, Harger, & Whitson, 2001; Huffman et al., 1998; Porges et al., 1996). Third, in line with expectations of validity and reliability, all the psychological measures of maturity should correspond with each other, in that high indices of maturity on one measure will reflect high maturity scores on the others.

METHODOLOGY

Participants

Participants were adolescent offenders recruited from the Tuscaloosa County Juvenile Detention Center and Juvenile Court, as part of a study looking at multi-method assessments of the Risk-Sophistication-Treatment Inventory Abbreviated (RSTI-A; Salekin, 2011) and a brief intervention. The adolescent sample consisted of 52 males (83.9%) and 10 females (16.1%) aged 13-18 years old (M = 15.98). The participants' race was primarily Black (N = 41; 66.1%), followed by White (N = 16; 25.8%) and Bi-racial (N = 1; 1.6%). Typical charges for this sample include, but are not limited to: robbery, burglary, domestic violence, possession of drugs, disorderly conduct, truancy, criminal mischief, and auto theft. These charges represent offenses that either led to the youths' incarceration or that required the youth's appearance in court.

Procedure

IRB approval was obtained before the study was initiated. Two graduate students, including this author, trained eight undergraduate research assistants (RAs) to aid with recruiting participants. Of these undergraduate RAs, four senior students also received extensive training from the graduate students in administering the psychological and physiological measures. Before testing began, informed consent was obtained from parents and assent from youth who participated in the study. Participants were informed that they were free to discontinue testing for any reason and at any time during the session. They were also informed that their participation withdrawal would in no way affect their placement at the detention center or their legal situation.

Those who agreed to participate were recruited from the Tuscaloosa County Juvenile Detention Center and completed testing procedures in a private, confidential room in the facility.

Those youth recruited from the Tuscaloosa County Juvenile Court participated in the testing session either in a quiet, private space within their home, or in a private area at a nearby library, depending on the youth's preferences. Youth completed all measures in one testing session, taking breaks between tasks when necessary. Youth who indicated difficulty with reading were read items aloud. The average room temperature across all testing sessions was 71.9 degrees Fahrenheit and the average relative humidity was 57.0 %. This was indexed with a hand held combination temperature/ humidity gauge.

Measures

Previous studies have used the PSMI and WAI to examine maturity factors (Cauffman & Steinberg, 2000; Colwell et al., 2005; Cruise et al., 2008; Little & Steinberg, 2006; Modecki, 2008; Monahan, Steinberg, & Cauffman, 2009). The Risk-Sophistication-Treatment Inventory – Self Report (RSTI-SR; Salekin & Iselin, 2008; see also Leistico & Salekin, 2003; Salekin, 2004) is another psychological instrument that includes a Sophistication-Maturity subscale. The RSTI-SR and PSMI were completed before the BioLog™ physiological data recorder was introduced and administered, and then participants completed the WAI.

Physiological data recorder. A BioLog™ recorder was administered to measure heart rate and skin conductance. This ambulatory data logger has been extensively used by researchers, including investigating generalized anxiety disorders, motion sickness, and aggression in children (Hubbard et al., 2002; Muth & Elkins, 2007; Rotha et al., 2008). Before the recording began, participants were notified they would be hooked up to a machine to view and measure their heart rate and skin response, and that the machine would not hurt. They were also given the following instructions:

In this situation you will see numbers counting down on the computer screen from 12 to 0. One number will appear every second. When you see the number 0, you will hear a loud noise for 1 second (s). Sometimes this loud noise will come on without any warning, however. There is nothing you need to do in this task apart from keeping your head and body as still as you can. Do you have any questions?

Two skin conductance electrodes (silver/ silver chloride) were filled with Biogel (UFI; Morro Bay, CA) cream, an electrolyte contact medium, and attached to the index and middle finger of the participants' non-dominant hand using adhesive tape. Three heart electrodes were also be placed on the inside of the participants' left, inner knee, just above the right collar bone, and on the right side of the neck. In order to collect baseline heart rate and skin conductance information, participants were instructed to remain still for three minutes while fixating on a black dot against a white background displayed on a computer monitor positioned 1 m in front of them. Following the baseline state, recording was paused and the WAI self-report measure was administered. Participants were then instructed to observe the computer monitor while wearing headphones. A countdown stressor was presented, used by Fung and colleagues (Fung et al., 2005), and modeled after a similar task used by Iacono and colleagues (Iacono, 1998; Taylor, Carlson, Iacono, Lykken, & McGue, 1999). The task consists of five trials. In Trials 1, 3, and 5 (signaled trials), a numeric countdown running from 12 to 0 is displayed in the center of the screen at the rate of one number per second. When 0 appears, a 1-s burst of 90-dB white noise with a 50-ms rise and fall time is heard through the headphones. On Trials 2 and 4 (un-signalled trials), no numeric countdown is visually displayed prior to the noise burst. The inter-trial interval is approximately 45 seconds, and participants were not made aware of the number of trials or the alternating nature of the trials. The computer-generated white noise burst was

consistently kept at 90-dB across all trials and participations, and was evaluated for intensity using dB Volume by DSP Mobile, an iPhone® app found to accurately evaluate noise conditions under 95-dB (Keene et al., 2013).

Scoring of physiological data recorder. For the purpose of this study, RSA and SCL baseline and reactivity data were calculated only for Trial 1. Similar to other research (e.g., Diamond et al., 1992), RSA and SCL baseline data was calculated as an average of the three minute baseline state and the 12 second "anticipatory stage" that occurred before the noise burst. RSA and SCL reactivity is defined as the difference between the RSA and SCL preceding the response to the noise burst (baseline) and the RSA and SCL at the peak of the response curve. This calculation mimics that of delta vagal tone, which is computed by subtracting vagal tone during an attention-demanding or challenging task from baseline vagal tone (El-Sheikh et al., 2001; Katz & Gottman, 1997).

RSA was derived from techniques in the manual Inter-Beat-Interval Editing for Heart Period Variability Analysis: An Integrated Training Program with Standards for Student Reliability Assessment (2007b). This manual is designed to be used alongside the CardioEdit and CardioBatch computer programs developed by Dr. Stephen Porges, director of the Brain and Body Center at the University of Illinois. The first procedure involved cleaning interbeat interval data collected using the Biolog. As per procedures outlined in the manual, each participant's heart rate data was hand edited in order to remove any unwanted artifacts. Artifacts are errors in the interbeat interval data that are likely due to the digitizing process of the data or to physiological anomalies. After data cleaning, RSA was extracted from one of the predominant rhythms exhibited in the data via computations of the participant's heart period series using the computer software. Porges' vagal tone method of calculating RSA is empirically supported

(Denver, Reed, & Porges, 2007a; Grossman, VanBeek, & Wientjes, 1990; Porges, 2007a). SCL was scored on the non-dominant hand of the participant for Trial 1 (in µ ohms). Baseline SCL for each participant was calculated by averaging SCL values within the three minute baseline period and the 12 second anticipatory stage.

Risk-Sophistication-Treatment Inventory – Self-Report (RSTI-SR). The RSTI-SR is a 74 item self-report inventory designed to assess risk (16 items), sophistication-maturity (30 items), and treatment amenability (28 items). The RSTI-SR is modeled after the RSTI (Salekin, 2004), which has demonstrated reliability, and construct and predictive reliability (Leistico & Salekin, 2003). Two studies have used the RSTI-SR effectively (Salekin, Lester, & Sellers, 2012; Salekin, Tippey, & Allen, 2012). The RSTI-SR is rated on a three-point scale, with available responses of "No" (0), "Sometimes" (1), and "Yes" (2). This study only used the Sophistication-Maturity scale, which includes three clusters: Autonomy (S-AUT), Cognitive Capacities (S-COG), and Emotional Maturity (S-EMO). There is demonstrated support for the reliability, and both construct and predictive validity of the RSTI-SR.

Weinberger Adjustment Inventory (WAI). The WAI was developed to measure social-emotional adjustment in older children and adults. The WAI is an 84 item self-report scale that assesses the way in which a subject habitually reacts to conflict and stressful situations, as measured by a 5-point Likert scale. The WAI comprises two superordinate dimensions: Subjective Experience of Distress and Self-Restraint. This study only used the Self-Restraint dimension, which is defined by four scales: Responsibility, Impulse Control, Suppression of Aggression, and Consideration of Others. Concurrent and predictive validities for the WAI have been established by both cross-sectional and longitudinal research (Feldman & Weinberger, 1994; Weinberger, 1996; Weinberger, 1998; Weinberger & Gomes, 1995).

Psychosocial Maturity Inventory (PSMI). The PSMI is a 30-item measure that assesses youths' work orientation, self-reliance, and identity. Items are scored on a 4-point Likert scale (1 = strongly agree, to 4 = strongly disagree). The Work-Orientation subscale (10 items) assesses capacity to experience pleasure in work and in the successful completion of tasks. The Self-Reliance subscale (10 items) assesses independence in decision-making, control over one's life, and the ability to take initiative. Finally, the Self-Identity subscale (10 items) assesses self-concept, internalized values, and concerns over life goals. Past research has shown the PSMI to possess psychometrically sound properties (Cauffman & Steinberg, 2000; Colwell et al., 2005).

DATA ANALYSIS PLAN

The first step of analyses included running descriptive statistics of both the self-report and physiological measures of maturity in the total sample. Research indicates that demographics such as gender and age predict scores on maturity measures (Fried & Reppucci, 2001; Cauffman & Steinberg, 2000), thus an independent-samples t-test was used to compare the self-report maturity and physiological measure of maturity scores for males and females. The reliability of the self-report maturity measures was then calculated using Cronbach's alpha (α). Preliminary analyses were performed to ensure no violations of normality, linearity, multicollinearity, and homoscedasticity.

Next, correlation analyses were performed to examine the relationship between the following variables: baseline RSA, RSA reactivity, baseline SCL, SCL reactivity and total and subscale scores of the RSTI-SR, WAI, and PSMI. A correlation analysis was also conducted to examine the relationship between age and maturity scores.

Finally, regression models were used to further evaluate whether baseline RSA and SCL and RSA and SCL reactivity could predict high levels of maturity as measured by the three dependent psychological assessments (the RSTI-SR, the PSMI, and the WAI), controlling for age. Age was entered on the first block, and the three psychological measures were entered simultaneously on the second block.

RESULTS

Preliminary Analyses

For descriptive statistics of both self-report and physiological measures, please refer to Table 1. Results from the independent-samples t-test comparing the self-report maturity and physiological measure of maturity scores revealed no significant difference in maturity scores for males and females. Given the extremely small sample of females in the study, and the lower power associated with these analyses, only results for the total sample are reported. The descriptive results for the female sample can be found in Table 1. The internal consistency of the RSTI-SR Sophistication-Maturity scale, the WAI Self-Restraint dimension, and the PSMI were all adequate using Cronbach's alpha ($\alpha = 0.83$, $\alpha = 0.83$, and $\alpha = 0.86$, respectively).

Table 1

Study Variable Descriptives, Including Total and Subscale Scores

Scale	Mean	SD	N
RSA Baseline	7.35	1.07	57
	7.63	1.20	9
RSA Reactivity	0.02	.943	57
	-0.14	0.50	9
SCL Baseline	5.44	4.20	35
	3.14	31.4	7
SCL Reactivity	8.54	6.94	35
	5.96	7.13	7
RSTI-SR SopMat	41.95	8.18	62
	39.70	5.96	10
Autonomy	19.61	4.69	62
	18.30	4.72	10
Cognition	11.35	2.82	62
	10.70	2.11	10
Emotion	10.98	3.13	62
	10.70	2.36	10
WAI	97.55	13.50	62
	99.30	10.12	10
Suppression	22.05	5.25	62
	22.90	5.30	10
Impulse Control	26.94	4.72	62
	26.80	3.61	10
Consideration	19.32	4.88	62
	20.40	4.65	10
Responsibility	29.24	5.61	62
	29.20	4.50	10
PSMI	87.16	11.65	62
	86.60	11.36	10
Self-Reliance	31.53	5.05	62
	32.40	4.03	10
Identity	30.08	5.50	62
	29.60	4.81	10
Work Orientation	27.26	4.75	62
	25.40	4.81	10

Note: For each cell, the value on the top is for the overall sample, while the value on the bottom is for the female sample

SD = standard deviation

N = sample size

RSA Baseline= Rhythmic Sinus Arrhythmia Baseline Level, RSA Reactivity= Rhythmic Sinus Arrhythmia Reactivity Level, SCL Baseline= Skin Conductance Baseline Level, SCL Reactivity= Skin Conductance Reactivity Level RSTI-SR SopMat= Risk Sophistication Treatment Inventory- Self Report Sophistication-Maturity Scale total score, Autonomy= RSTI-SR Autonomy Subscale, Cognition= RSTI-SR Cognition Subscale, Emotion= RSTI-SR Emotion subscale, WAI= Weinberger Adjustment Inventory Total Score, Suppression= WAI Suppression of aggression Subscale, Impulse Control= WAI Impulse Control Subscale, Consideration= WAI Consideration of Others Subscale, WAI Responsibility= WAI Responsibility Subscale, PSMI= Psychosocial Maturity Inventory Total Score, Self-Reliance= PSMI Self-Reliance Subscale, Identity= PSMI Identity Subscale, Work Orientation= PSMI Work Orientation Subscale

Correlation Analyses

Evidence suggests that low baseline RSA and SCL patterns indicate poor emotion regulation (Beachaine, 2001; Raine, 2005), and Pearson product-moment correlations were first used to examine the relationship between baseline RSA and SCL patterns and self-reported maturity levels (see Table 2). Contrary to expectations, results indicated medium-to-large, negative associations between baseline RSA and SCL patterns and scores on the self-report maturity measures. Although no associations were revealed between baseline RSA levels and maturity scores, baseline SCL levels were negatively related to the PSMI Work Orientation subscale (r = -0.42, p < .05). Baseline SCL patterns were further negatively associated with the WAI Total score (r = -0.52, p < .01), the WAI Suppression subscale (r = -0.35, p < .05), the WAI Impulse control subscale (r = -0.52, p < .01), and the WAI Responsibility subscale (r = -0.59, p < .01). Furthermore, both baseline RSA and SCL levels were positively related to SCL reactivity levels (r = 0.35, p < .05; and r = 0.91, p < .01, respectively).

In light of research indicating increased vagal tone suppression (high RSA and SCL activity) during arousing situations reflects more adaptive regulation and executive functioning (El-Sheikh et al., 2001; Huffman et al., 1998; Porges et al., 1996), the relationships between RSA and SCL reactivity levels and maturity scores were also investigated. Results are shown in Table 2. Pearson product-moment correlation analyses revealed negative associations between RSA reactivity and scores on the WAI total scale (r = -0.36, p < .01), the WAI Suppression of Aggression subscale (r = -0.26, p < .05), the WAI Impulse Control subscale (r = -0.31, p < .05), the WAI Responsibility subscale (r = -0.44, p < .01), and the RSTI-SR Emotion subscale (r = -0.32, p < .05). With regard to SCL reactivity scores, negative relationships were found between these patterns and the WAI total scale (r = -0.48, p < .01), the WAI Impulse Control subscale (r

= -0.46, $p < .01$), the WAI Responsibility subscale ($r = -0.57$, $p < .01$), and the PSMI Work Orientation subscale ($r = -0.43$, $p < .05$, respectively).

Table 2

Correlations Between Physiological and Self-Report Measures of Maturity, Including Total and Subscale Scores

Scale	RSA Baseline	RSA Reactivity	SCL Baseline	SCL Reactivity
RSA Baseline	--	0.26	0.26	0.35*
RSA Reactivity	0.26	--	0.18	0.11
SCL Baseline	0.26	0.18	--	0.91**
SCL Reactivity	0.35*	0.11	0.91**	--
RSTI-SR Sophistication-Maturity	-0.02	-0.09	-0.07	-0.07
RSTI-SR Autonomy	0.08	-0.00	0.09	0.05
RSTI-SR Cognition	-0.05	-0.04	-0.20	-0.11
RSTI-SR Emotion	-0.11	-0.32*	-0.18	-0.18
WAI	-0.09	-0.36**	-0.52**	-0.48**
WAI Suppression	-0.06	-0.26*	-0.35*	-0.32
WAI Impulse Control	-0.17	-0.31*	-0.52**	-0.46**
WAI Consideration	0.18	0.03	0.05	0.05
WAI Responsibility	-0.16	-0.44**	-0.59**	-0.57**

Note: ** Indicates correlation is significant at the .01 level; * Indicates correlation is significant at the .05 level

RSTI-SR SopMat= Risk Sophistication Treatment Inventory- Self Report Sophistication-Maturity Scale total score, Autonomy= RSTI-SR Autonomy Subscale, Cognition= RSTI-SR Cognition Subscale, Emotion= RSTI-SR Emotion subscale, WAI= Weinberger Adjustment Inventory Total Score, Suppression= WAI Suppression of aggression Subscale, Impulse Control= WAI Impulse Control Subscale, Consideration= WAI Consideration of Others Subscale, WAI Responsibility= WAI Responsibility Subscale, PSMI= Psychosocial Maturity Inventory Total Score, Self-Reliance= PSMI Self-Reliance Subscale, Identity= PSMI Identity Subscale, Work Orientation= PSMI Work Orientation Subscale

In order to examine the reliability and validity of the currently used psychological measures of maturity, Pearson product-moment correlations were also used to investigate the relation between total and subscale scores of the RSTI-SR, WAI, and PSMI. In terms of total scores (see Table 3), the RSTI-SR Sophistication scale significantly corresponded with the PSMI ($r = 0.36$; $p < .01$), but not the WAI. The total scores of PSMI and the WAI also had a significant association ($r = 0.37$; $p < .01$)

Table 3 presents all correlations between subscale scores, but only significant correlations between subscale scores are reported here. With regard to the RSTI-SR Maturity-Sophistication subscales, Autonomy ($r = 0.86$; $p < .01$), Cognition ($r = 0.61$; $p < .01$), and Emotion ($r = 0.78$; $p < .01$) are all associated with the total scale score. Correlations were also found between Autonomy and Cognition ($r = 0.26$; $p < .05$) and Emotion ($r = 0.51$; $p < .01$), as well as between Cognition and Emotion ($r = 0.30$; $p < .05$). Autonomy was further related to WAI Suppression of aggression ($r = -0.27$; $p < .05$). Cognition corresponded to total scores for the WAI ($r = 0.26$; $p < .05$) and the PSMI and PSMI total score ($r = 0.31$; $p < .05$). Emotion was also associated with the WAI total score ($r = 0.32$; $p < .05$), the WAI Responsibility subscale ($r = 0.25$; $p < .05$), and the PSMI total score ($r = 0.30$; $p < .05$).

The PSMI revealed several significant associations both within subscales and with the WAI subscales. The PSMI total score was correlated with PSMI Self-Reliance ($r = 0.81$; $p < .01$), PSMI Identity ($r = 0.86$; $p < .01$), PSMI Work Orientation ($r = 0.79$; $p < .01$). Several WAI subscale scores were also positively associated with the PSMI total score including WAI Impulse Control ($r = 0.26$; $p < .05$) and WAI Responsibility ($r = 0.41$; $p < .01$). PSMI Work Orientation scale was related to PSMI Self-Reliance ($r = 0.45$; $p < .01$), PSMI Identity ($r = 0.54$; $p < .01$). With regard to the WAI subscales, PSMI Work Orientation was associated with WAI Suppression of aggression ($r = 0.35$; $p < .01$), WAI Impulse Control ($r = 0.38$; $p < .01$), and WAI Responsibility ($r = 0.54$; $p < .01$). The PSMI Identity scale was significantly correlated with PSMI Self-Reliance ($r = 0.55$; $p < .01$) and WAI Responsibility scale ($r = 0.33$; $p < .01$).

The WAI total score was related to WAI Suppression of Aggression ($r = 0.76$; $p < .01$), WAI Impulse Control ($r = 0.73$; $p < .01$), WAI Consideration ($r = 0.27$; $p < .05$), WAI Responsibility ($r = 0.85$; $p < .01$), PSMI Identity ($r = 0.33$; $p < .01$), and PSMI Work Orientation

(r = 0.32; p < .05). WAI Suppression of Aggression further corresponded to WAI Impulse Control (r = 0.49; p < .01) and Responsibility (r = 0.51; p < .01). An association was also found between WAI Impulse Control and Responsibility (r = 0.65; p < .01).

Finally, a correlation analysis was conducted to examine the relationship between age and maturity scores. Results revealed a significant, negative relation between age and scores on the total WAI scale (r = -.301, p < .05), the WAI Suppression of Aggression subscale (r = -.338, p < .01), and the WAI Responsibility subscale (r = -.292, p < .05), therefore age was controlled for in all regression analyses.

Table 3

Correlations Between Self-Report Measures of Maturity, Including Total and Subscale Scores

Scale	SM	AUT	COG	EMO	WAI	SUP	IC	CON	RES	PSMI	SR	ID	WO
SM	--	0.86**	0.61**	0.78**	0.17	-0.04	0.08	0.25	0.17	0.36**	0.20	0.25	0.44**
AUT	0.86**	--	0.26*	0.51**	-0.07	-0.27*	-0.11	0.23	-0.11	0.23	0.09	0.23	0.26*
COG	0.61**	0.26*	--	0.30*	0.26*	0.15	0.16	0.13	0.23	0.31*	0.22	0.17	0.38**
EMO	0.78**	0.51**	0.30*	--	0.32*	0.17	0.23	0.19	0.25*	0.30*	0.20	0.15	0.42**
WAI	0.17	-0.07	0.26*	0.32*	--	0.76**	0.73**	0.27*	0.85**	0.29*	0.08	0.33**	0.52**
SUP	-0.04	-0.27*	0.15	0.17	0.76**	--	0.49**	-0.05	0.49**	0.76**	-0.11	0.21	0.35**
IC	0.08	-0.11	0.16	0.23	0.73**	0.49**	--	-0.02	0.65**	0.73**	0.05	0.23	0.38**
CON	0.25	0.23	0.13	0.19	0.27*	-0.05	-0.24	--	0.02	0.27*	0.17	0.02	0.09
RES	0.17	-0.11	0.23	0.25*	0.85**	0.51**	0.65**	0.02	--	0.85**	0.09	0.38**	0.54**
PSMI	0.36**	0.23	0.31*	0.30*	0.37**	0.18	0.26*	0.11	0.41**	--	0.81**	0.86**	0.79**
SR	0.20	0.09	0.22	0.20	0.08	-0.11	0.05	0.17	0.09	0.81**	--	0.55**	0.45**
ID	0.25	0.23	0.17	0.15	0.33**	0.21	0.23	0.02	0.38**	0.86**	0.55**	--	0.54**
WO	0.44**	0.26*	0.38**	0.42**	0.52**	0.35**	0.38**	0.09	0.54**	0.79**	0.45**	0.54**	--

Note: ** Indicates correlation is significant at the .01 level; * Indicates correlation is significant at the .05 level

SM= Risk Sophistication Treatment Inventory- Self Report Sophistication-Maturity Scale total score, AUT= RSTI-SR Autonomy Subscale, COG= RSTI-SR Cognition Subscale, EMO= RSTI-SR Emotion subscale, WAI= Weinberger Adjustment Inventory Total Score, SUP= WAI Suppression of aggression Subscale, IC= WAI Impulse Control Subscale, CON= WAI Consideration of Others Subscale, RES= WAI Responsibility Subscale, PSMI= Psychosocial Maturity Inventory Total Score, SR= PSMI Self-Reliance Subscale, ID= PSMI Identity Subscale, WO= PSMI Work Orientation Subscale

Regression Analyses

Hierarchical multiple regressions were used to assess the ability of both RSA and SCL baseline and reactivity levels to predict scores on these scales, after controlling for the influence of age. Age was entered in step 1, but did not significantly explain any variance in self-report maturity scores. As seen in Table 4, only the overall model for the WAI total score, WAI Impulse Control, and WAI Responsibility subscales were significant. In terms of predicting WAI total scores, after entry of baseline RSA, RSA reactivity, baseline SCL, and SCL reactivity in step 2, the total variance explained by the model as a whole was 46%, $F(4, 28) = 4.81$, $p < .01$. The physiological scores explained an additional 37% of the variance in WAI total scores, R^2 change = 0.37. In terms of predicting WAI Impulse Control subscale scores, after entry of baseline RSA, RSA reactivity, baseline SCL, and SCL reactivity in step 2, the total variance explained by the model as a whole was 32%, $F(4, 28) = 2.63$, $p < .05$. The physiological scores explained an additional 32% of the variance in WAI Impulse Control subscale scores, R^2 change = 0.32. In terms of predicting WAI Responsibility scores, after entry of baseline RSA, RSA reactivity, baseline SCL, and SCL reactivity in step 2, the total variance explained by the model as a whole was 56%, $F(4, 28) = 7.26$, $p < .05$. The physiological scores explained an additional 48% of the variance in WAI Responsibility subscale scores, R^2 change = 0.48. According to Table 5, there were no significant baseline RSA or SCL beta coefficients predicting maturity levels, and only RSA reactivity significantly, negatively predicted scores on the WAI total scale and the WAI Responsibility subscale ($\beta = -0.36$, $p < .05$; and $\beta = -0.42$, $p < .01$, respectively).

Table 4

Hierarchical Multiple Regression Analyses Predicting Self-Report Maturity Scale Scores With RSA and SCL Values (Baseline and Reactivity)

	Model 1				Model 2			
Dependent Variable	df	F	R^2	R^2 change	df	F	R^2	R^2 change
RSTI-SR Sophistication-Maturity	1, 32	0.09	0.00	0.00	4, 28	0.10	0.02	0.02
RSTI-SR Autonomy	1, 32	0.51	0.02	0.02	4, 28	0.08	0.36	0.05
RSTI-SR Cognition	1, 32	0.11	0.00	0.00	4, 28	0.72	0.11	0.11
RSTI-SR Emotion	1, 32	0.00	0.00	0.00	4, 28	0.57	0.09	0.09
WAI	1, 32	3.19	0.09	0.09	4, 28	4.81**	0.46	0.37
WAI Suppression	1, 32	4.14	0.12	4.14	4, 28	2.15	0.28	0.16
WAI Impulse Control	1, 32	0.06	0.00	0.00	4, 28	2.63*	0.32	0.32
WAI Consideration	1, 32	0.26	0.01	0.01	4, 28	0.28	0.05	0.04
WAI Responsibility	1, 32	2.98	0.09	0.09	4, 28	7.26*	0.56	0.48
PSMI	1, 32	0.01	0.00	0.00	4, 28	0.59	0.10	0.10
PSMI Self-Reliance	1, 32	0.55	0.02	0.02	4, 28	0.38	0.06	0.05
PSMI Identity	1, 32	0.18	0.01	0.01	4, 28	0.47	0.08	0.07
PSMI Work Orientation	1, 32	0.24	0.01	0.01	4, 28	1.37	0.20	0.19

Note: df = degrees of freedom

** Indicates correlation is significant at the .01 level; * Indicates correlation is significant at the .05 level

RSTI-SR SopMat= Risk Sophistication Treatment Inventory- Self Report Sophistication-Maturity Scale total score, Autonomy= RSTI-SR Autonomy Subscale, Cognition= RSTI-SR Cognition Subscale, Emotion= RSTI-SR Emotion subscale, WAI= Weinberger Adjustment Inventory Total Score, Suppression= WAI Suppression of aggression Subscale, Impulse Control= WAI Impulse Control Subscale, Consideration= WAI Consideration of Others Subscale, WAI Responsibility= WAI Responsibility Subscale, PSMI= Psychosocial Maturity Inventory Total Score, Self-Reliance= PSMI Self-Reliance Subscale, Identity= PSMI Identity Subscale, Work Orientation= PSMI Work Orientation Subscale

Table 5

Hierarchical Multiple Regression Analyses Predicting Self-Report Maturity Scale Scores with RSA and SCL Values (Baseline and Reactivity): Coefficients

	Model 1	Model 2				
	Age	Age	Baseline RSA	RSA Reactivity	Baseline SCL	SCL Reactivity
Dependent Variable	β	β	β	β	β	β
RSTI-SR SopMat	0.05	0.08	0.03	-0.09	0.09	-0.18
RSTI-SR Autonomy	0.13	0.21	0.10	-0.04	0.55	-0.55
RSTI-SR Cognition	-0.06	-0.16	0.11	0.11	-0.86	0.74
RSTI-SR Emotion	0.00	0.02	0.01	-0.25	0.06	-0.21
WAI	-0.30	-0.36*	0.16	-0.36*	-0.62	0.17
WAI Sup.	-0.34*	-0.42*	0.08	-0.19	-0.64	0.37
WAI Impulse Control	-0.04	-0.05	-0.23	-0.54	-0.54	0.07
WAI Cons.	-0.09	-0.13	0.20	-0.04	-0.01	0.03
WAI Res.	-0.29	-0.31*	0.13	-0.42**	-0.49	-0.04
PSMI	-0.12	0.02	-0.07	0.01	-0.28	-0.00
PSMI Self-Reliance	0.13	0.08	-0.18	0.03	-0.44	0.44
PSMI Identity	-0.07	0.00	0.03	0.05	-0.02	-0.27

Note: β = standardized regression coefficients

** Indicates correlation is significant at the .01 level; * Indicates correlation is significant at the .05 level

RSTI-SR Sop-Mat = Risk Sophistication Treatment Inventory- Self Report Sophistication-Maturity Scale total score, Autonomy= RSTI-SR Autonomy Subscale, RSTI-SR Cognition= RSTI-SR Cognition Subscale, RSTI-SR Emotion= RSTI-SR Emotion subscale, WAI= Weinberger Adjustment Inventory Total Score, WAI Sup.= WAI Suppression of aggression Subscale, WAI Impulse Control= WAI Impulse Control Subscale, WAI Cons.= WAI Consideration of Others Subscale, WAI Res.= WAI Responsibility Subscale, PSMI= Psychosocial Maturity Inventory Total Score, PSMI Self-Reliance= PSMI Self-Reliance Subscale, PSMI Identity= PSMI Identity Subscale, PSMI W.O.= PSMI Work Orientation Subscale

DISCUSSION

Taking into account the legal recognition of maturity as a mitigating factor for adolescent offenses, it is necessary that decision makers such as judges and advocates such as lawyers and mental health professionals be guided by empirical understanding of the concept. The present study built upon previous research linking maturity to adolescent offending, and maturity to physiological processes, by examining the relationship between psychological and neurobiological expressions of maturity. The results of this study demonstrate that maturity appears to be composed of several different constructs that can be reliably indexed using both psychological and physiological measurements. In light of evidence suggesting that low baseline RSA and SCL patterns indicate poor emotion regulation (Beachaine, 2001; Raine, 2005), this study's first hypothesis proposed that low RSA and SCL values would be associated with and predict lower scores on the self-report maturity scales. Although no significant associations were found between baseline RSA activity and maturity scores, there were several significant relationships found between baseline SCL levels and various maturity scales, albeit not in the expected direction. In particular, it appears that maturity as defined by the WAI is associated with and predicted by RSA and SCL activity. Lower baseline SCL levels were found to be associated with higher WAI total scores and higher WAI Suppression of aggression, WAI Impulse Control, and WAI Responsibility subscale scores. Additionally, higher scores on the PSMI Work-Orientation subscale were significantly related to lower levels of baseline SCL.

With regard to the second hypothesis, it was expected that lower RSA and SCL levels following the signaled noise burst (RSA/ SCL reactivity) would be associated with lower scores

on the self-report maturity scales. High RSA/ SCL reactivity levels are thought to demonstrate poor response inhibition, in line with research indicating increased vagal tone suppression (low RSA and SCL activity) occurs during arousing situations. In turn, low RSA and SCL reactivity have been linked to greater emotion regulation, and executive abilities such as sustained attention, cognitive processing, and organization of responding to stressful conditions (El-Sheikh et al., 2001; Huffman et al., 1998; Porges et al., 1996). Again, all significant relationships were found to be in the opposite direction of what had been predicted. Similar to the first hypothesis, of all the self-report maturity measures, it appears as though total and subscale scores as measured by the WAI had the greater number of significant associations with RSA and SCL reactivity. Decreased RSA and SCL reactivity values were related to higher scores on the WAI total scale, and the WAI Suppression of Aggression, WAI Impulse Control, and WAI Responsibility subscales. Patterns of lower RSA levels were also found to be associated with increased scores on the RSTI-SR Sophistication-Maturity Emotion subscale, while lower SCL levels were significantly associated with higher scores on the PSMI Work Orientation subscale. Notably, regression analyses revealed that only scores on the WAI total scale and the WAI Responsibility subscale significantly predicated RSA reactivity values, controlling for age.

This study's third investigation into the expected associations between scales revealed that although some scales (and thus, constructs of maturity) map onto each other as expected, others do not. The greatest number of between-scale associations appeared to stem from one's pride in the ability to successfully accomplish tasks (as measured by the PSMI Work Orientation subscale). This skill set was significantly related to the ability to regulate emotions (RSTI-SR Sophistication-Maturity), demonstrate high-level cognitive skills (RSTI-SR Sophistication-Maturity), maintain a clear sense of identity (RSTI-SR Sophistication-Maturity), suppress

aggression (WAI), control impulsivity (WAI), and be responsible (WAI). All three subscales of the PSMI were related to one another, indicating that the following traits all tap into one construct of maturity as measured by the PSMI: taking pride in one's ability to successfully accomplish tasks, self-esteem, clarity of the self, and consideration of life goals, and feelings of internal control and the ability to make decisions without extreme reliance on others. However, other than Work Orientation, no other PSMI subscales matched onto the subscales of the WAI or the RST-SR Sophistication-Maturity scale.

All but one of the subscales on the WAI mapped onto other subscales, suggesting that the consideration of others is a construct not particularly relevant to an overall definition of maturity as provided by the authors of the WAI, PSMI, and RSTI-SR Sophistication-Maturity. Like the PSMI, all three subscales of the RSTI-SR Sophistication-Maturity scale corresponded with each other, indicating that high-level cognitive skills, an ability to regulate emotions, and a clearer sense of identity are related facets of an overall construct of maturity as defined by the RSTI-SR Sophistication-Maturity scale. Yet unlike the PSMI, the subscales of the RSTI-SR Sophistication-Maturity scale mapped onto other subscales. A clearer sense of identity and high-level cognitive skills, as measured by the Autonomy and Cognition subscales of the RSTI-SR Sophistication-Maturity scale was related to the ability to suppress aggression (WAI), and one's pride in the ability to successfully accomplish tasks (WAI). In turn, the ability to regulate emotions (Emotion subscale) was associated with the ability to be responsible (WAI) and again taking pride in one's ability to successfully accomplish tasks (PSMI).

Overall, results from this study suggest that adolescent maturity is composed of several different constructs and some constructs appear to share neurobiological underpinnings. Specifically, this study examined emotional reactivity as one executive function linked to

maturity (Cauffman & Steinberg, 2000; Galambos et al., 2003, Galambos et al., 2005). Using Patrick and colleagues' (2012) model of defensive reactivity as a neurobehavioral trait construct, it appears that certain abilities indicative of maturity are specific to emotional reactivity, while others are not. The association with skin conductance and vagal tone levels demonstrates that the ability to regulate emotions, suppress anger, control impulsivity, demonstrate responsibility, and take pride in one's ability to successfully accomplish tasks are all important components of emotional reactivity. These traits also corresponded with each other on psychological measures. These results provide further support for the idea that emotional reactivity is one construct of adolescent maturity composed of several sub-constructs, which in turn can be reliably indexed using both physiological and psychological avenues.

However, the negative associations found between the aforementioned traits and physiological reactivity did not echo the findings traditionally highlighted in the empirical literature, in that an increase in maturity traits such as emotional reactivity is related to increased RSA and skin conductivity patterns, and presumably, higher heart rate (Beauchaine, 2001). This finding likely suggests a developmental difference, where high RSA/SCL patterns and corresponding increased heart rate act as an alert system that enables adolescent offenders to easily recognize stressful situations and demonstrate maturity skills such as emotion regulation as coping responses. An alternative explanation may be that seeing as research indicates adolescent offenders with high RSA/SCL patterns (and low heart rate) demonstrate psychopathic traits, their inability to demonstrate empathy or concern may cause decreased maturity scores (e.g., Raine, Venables, & Williams, 1990a; Raine, Venables, & Williams, 1990b). Lastly, research indicates that the heart rate-RSA relation is dysregulated in aggressive/anti-social youth, in that SNS-controlled heart rate has been decreased at the same time as PNS- controlled RSA

(Mezzacappa et al., 1997). Perhaps this study's sample of young offenders also reflects this inverse heart rate-RSA relation. It may be that the high RSA/low maturity relationship found among this study's youth actually suggests a high heart rate/ low maturity relationship, which has been typically supported by the literature.

Although those maturity characteristics with ties to emotional reactivity also demonstrated correspondence with other maturity characteristics such as high-level cognitive skills, maintaining a clear sense of identity, self-esteem, clarity of the self, consideration of life goals, feelings of internal control and the ability to make decisions without extreme reliance on others, it may be that the lack of correspondence with RSA and SCL values reflects the inability of these sub-traits to map onto the construct of emotional reactivity. It is not surprising that not all maturity traits identified by this study would be specific to emotional reactivity, as the concept of maturity has been given multiple definitions by various researchers. Additionally, the varying correspondence between subscale and total scores of the self-report measures of maturity implies that current psychological assessments are commonly measuring some constructs contributing to a definition of maturity, but are also measuring some unique ones.

In the midst of significant, neurobiologically-based revisions to major diagnostic classification systems such as the newly revised Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-Five; American Psychiatric Association, 2013) and the International Classification of Diseases, Tenth Revision (ICD-10; World Health Organization, 2004), researchers have continued to focus on neurobiologically based approaches to defining, studying and treating mental health issues such as disruptive behavior (Hyman, 2007; Insel & Scolnick, 2006; Patrick et al., 2012; Sanislow et al., 2010). Adolescent offenders are one group of individuals whose behavior can be described as severely disruptive, with long-term

consequences for the adolescents, their families, and those in the community. Several risk factors have been pinned as contributing to offending behavior, but maturity appears to be unique in both how it appears in adolescents, and the legal consequences attached to this construct. While some research indicates that detained youth demonstrate mature traits such as greater perspective-taking than non-detained youth (Fried & Reppucci, 2001), other studies have found adolescent offenders demonstrate lack of responsibility, perspective, and temperance, when making decisions about risky or antisocial behavior as compared to adults (Cauffman & Steinberg, 2000). Yet other researchers posit that maturity factors may appear as both pro-social and antisocial in adolescent offenders (Garfield, 1994; Salekin et al., 2001; Taylor et al., 1998). Furthermore, the ability of decision-makers to transfer adolescents to adult court using the existence of maturity as a mitigating factor confirms maturity's uniqueness.

With consideration of the need for greater understanding of maturity in adolescent offenders, and the tendency for recent focus on neurobiological processes, this study makes important contributions to the present literature on adolescent maturity by building on established research. First, in addition to employing commonly used measures of maturity (WAI and PSMI), this study has attempted to expand how maturity may be defined by using the RSTI-SR Sophistication-Maturity scale. The WAI and PSMI have been empirically validated for maturity of judgment factors (Cauffman & Steinberg, 2000; Colwell et al., 2005; Cruise et al., 2008; Little & Steinberg, 2006; Modecki, 2008; Monahan et al., 2009), however there has been no measurement specifically developed for adolescent offenders that has been used in the literature. Thus, the RSTI-SR was used to provide information on sophistication-maturity, a concept that appears to map onto maturity of judgment factors and better reflects the core maturity construct relevant to the psychological assessment of adolescent offenders for transfer

proceedings, as initially outlined under *Kent* criteria. Second, in light of the push to examine neurobiological traits constructs, this study built on the attempt to understand the relationship between adolescent offenders and executive processes by examining the autonomic processes underlining a maturity construct (emotional reactivity), and the possible sub-constructs expressed by adolescent offenders. Through the use of a physiological data recorder, this study has provided a stepping-stone for future study of maturity using more expensive, time-consuming technological techniques such as MRI machines. Third, the use of both psychological and physiological measures to examine maturity is a unique approach to understanding this construct. Some researchers have suggested that physiological tests are more sensitive, and less biased and uncensored in comparison to paper and pencil measures (Blascovich, Vanman, Mendes, & Dickerson, 2011), and so this study has allowed for evaluation of perhaps more reliable methods of indexing maturity.

Limitations and directions for future research

Nonetheless, this study has several limitations that must be taken into consideration. There was not have a non-offending sample to compare the study's sample to, and thus it is difficult to determine whether the levels of maturity demonstrated by these adolescent offenders reflects that which is typical of their age group, or that which is typical for their detained status. Nor is it possible to make any predictive inferences about the relationship between maturity and offending, as has been made by previous research (Chung et al., 2005; Barnes & Beaver, 2010; Cauffman & Steinburg, 2000; Little & Steinberg, 2006). This sample was also predominantly male and Black; although this generally reflects the demographics of juvenile correctional facilities in the Southeast, it will be important to replicate these findings with adolescents of different gender, ethnic, cultural, and class backgrounds. This is especially important in light of

evidence documenting gender differences for PNS functioning (Diamond et al., 2012; Graziano et al., 2007; Greaves-Lord et al., 2010; Sloan et al., 2001), including basic biological sex differences in the neural modulation of parasympathetic regulation of heart rate (Åhs, Sollers, Furmark, Fredrikson, & Thayer, 2009).

Seeing as this study only looked at one trait associated with maturity (emotional reactivity), and one neurobiological pathway to this trait (skin conductance and vagal tone), there remains an incomplete understanding of maturity. Future studies may wish to explore other ANS pathways that may contribute to emotional reactivity, and/or examine other executive functions reflecting maturity, such as decision making and problem solving. Since our results revealed that self-esteem, clarity of the self, internal control corresponded to other maturity characteristics, yet were not associated with ANS functioning, these abilities surrounding identity and the self may warrant further research attention.

Furthermore, although our physiological measure of choice (Biolog recorder) may be more reliable than a paper and pen measure of maturity, it is important to acknowledge that the recorder and the white-noise paradigm have limitations. It was impossible to control all aspects of the environment while recording heart rate and electrodermal responsivity, and so even as all efforts were made to take note of any event with the potential to affect heart rate and skin conductance levels (such as a door opening in the detention center, or a car driving by the library), it may be that RSA and SCL values were affected by uncontrollable stimuli. In addition to exploring other ANS pathways that may contribute to emotional reactivity, and/or other executive functions reflecting maturity, future studies may also wish to use physiological instruments that have more easily controlled environments, such as fMRI machines in a hospital setting. This study also did not test for whether the 90-dB white-noise burst was truly aversive,

which may explain the lack of many significant relationships between RSA and SCL reactivity and self-report maturity scores. Increasing sensitivity to human-participant considerations precluded the use of a more intense, aversive stimulus such as the 120-dB white noise that has been used in past research (e.g., Hare, 1978; Ogloff & Wong, 1990). An advantage of using less intense eliciting stimuli is the minimization of risk to participants from unnecessarily high acoustic stimulus intensities. The United States Occupational Safety and Health Act standards (OSHA standard number 1910.95) indicate that hearing protection is not required at a stimulus intensity of 105-dB SPL unless the sound is continuous for 1 hour. However, this refers to continuous stimulation, not to impulse stimuli, such as those used to elicit a physiological response. This study's use of a 90-dB white noise stimulus both falls below the level OSHA considers unsafe, and lies in between the auditory stimuli ranges of 75 and 90-dB that research has found to have evoked physiological responses (e.g., Zald & Pardo, 2002).

Additionally, the lack of many significant beta coefficients in this study's regression analyses may indicate that there are factors other than age that are contributing to the relationship between RSA and SCL values and self-report maturity scores. Indeed, links have been found between RSA/ SCL patterns and depression, anxiety, self-injury, aggression, and cognitive performance in adolescents (Beauchaine, 2001; Beauchaine et al., 2007; Crowell et al., 2005; Diamond et al., 2010 Eisenberg et al., 1995; El-Sheikh et al., 2007; Gordis et al., 2010; Shannon et al., 2007; Silk et al., 2003; Staton et al., 2008; Thayer & Lane, 2000). Additionally, the presence of psychopathy may also be a moderating factor to consider. Psychopathic traits are a common risk factor for adolescent offending (e.g., Edens & Campbell, 2007; Edens, Campbell, & Weir, 2007; Gretton, Hare, & Catchpole, 2004; Gretton, McBride, Hare, O'Shaughnessy, & Kumka, 2001) and given that psychopathy involves some sophisticated level of executive

functioning (e.g., deception, manipulation, etc.), psychopathic traits may reflect an antisocial use of higher maturity levels. Current evidence does suggest relationships exist between electrodermal responsivity and adolescent psychopathy, and psychopathy and adolescent maturity (Fung et al., 2005; Pan, 2010).

Treatment Implications

In terms of treatment, programs that identify individuals with reduced autonomic functioning at an early age could prove successful for preventing later disruptive behavior in adolescence. These programs could address behavioral expressions of reduced executive processes, such as decreased responsibility, decision-making skills, and impulse control. One nutritional, physical exercise, and educational enrichment program from ages 3 to 5 years has been shown to increase autonomic functioning at age 11 years, particularly for aversive tone stimuli (Raine et al., 2001). Early, targeted treatment may then address issues likely occurring in multiple areas (e.g., nutritional, educational, and psychophysiological), thus preventing those disruptive behaviors associated with reduced autonomic functioning, such as criminal offending, school dropout, and substance use.

Considering the legal implications for those youth who have already engaged in antisocial or criminal behavior, this study's results show evidence that maturity in adolescent offenders has ties with neurobiology and behavior, thus demonstrating potential for the development of neurobiologically-based treatment programs that may be used in conjunction with or as an alternative to harsh sentences for adolescent offenders. Currently, maturity's role in the youth criminal justice system is to guide decision making for transfers to/ from adult court, meaning that those youth who are more mature as seen as more "adult-like" and suitable for transfer to adult court. However, researchers have noted that youth with higher levels of maturity

might be more amenable to treatment, because those with greater cognitive skills, emotion regulation, and clearer identity are likely to benefit from psychotherapy and reach their treatment goals (Salekin et al., 2001; Garfield, 1994; Taylor, Pham, et al., 2008).

With regard to sophistication-maturity more specifically, it appears as though treatment amenability may be two-fold. In one study, adolescent offenders who demonstrated greater awareness of societal and personal standards, and the importance of prosocial behavior had greater responsiveness to treatment (Leistico & Salekin, 2003). However, those young offenders who held sophisticated delinquent attitudes and behaviors were found to display decreased amenability to treatment (Leistico & Salekin, 2003). The authors' conclusion that maturity can either serve to increase criminal behavior, or increase prosocial development (Leistico & Salekin, 2003) garners support for providing adolescent offenders with alternative, rehabilitative-focused sentences. Those adolescents with higher levels of maturity who are transferred to adult court, and who receive adult sentences, may not benefit from the often treatment-focused consequences given to those remaining in juvenile court. Increased maturity may actually serve as a risk factor for increased criminal behavior; consequently adolescents who receive adult sentences may not be given the opportunity to learn how to exercise their mature skills in a prosocial manner.

Conclusion

Evidence from this study and other literature indicates that maturity appears to have both neurobiological and behavior referents, implying that neuroscience could be used to back a diversionary model of youth justice. This is supported by the belief that adolescent offending is developmental, transient, and likely to be limited to adolescence (Walsh, 2010). Adolescents have only been recently recognized as being less culpable than adults in the legal sense, due to

their immaturity. Like the beloved fictional character Peter Pan, adolescents appear not to be as "grown-up" as was thought in the early development of the juvenile justice system, in part due to advancements in neuroscience and brain research. It is important that our understanding of the adolescent brain become more sophisticated, and with the aid of increasingly refined technology, it has become easier to identify and explore neurobiological trait constructs. There are an incredible amount of both risk and protective factors for adolescent offending and maturity, and the sub-construct of response inhibition is just one factor this study has attempted to understand. Armed with the knowledge about the developing adolescent brain and the potential for change provided by social experience, greater understanding of constructs such as maturity will guide the creation of more creative responses to offending. For those youth at risk at becoming Peter Pan, a child who never grows up, opportunities to validly facilitate and measure maturation are in need of continued development.

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APPENDIX

IRB#: 12-007-R1

UNIVERSITY OF ALABAMA INSTITUTIONAL REVIEW BOARD FOR THE PROTECTION OF HUMAN SUBJECTS
REQUEST FOR APPROVAL OF RESEARCH INVOLVING HUMAN SUBJECTS

I. Identifying information

	Principal Investigator	Second Investigator	Third Investigator	Fourth Investigator
Name:	Randy Salekin, PhD	Adelle Forth	Emily MacDougall	Chris Gillen
epartment:	Psychology	Psychology	Psychology	Psychology
College:	Arts & Sciences	Arts & Sciences	A&S	A&S
Jniversity:	University of Alabama	Carleton University	University of Alabama	Carleton University
Telephone:	(205) 348-6619		(205) 219-2260	
E-mail:	rsalekin@as.ua.edu	aforth@carleton.ca	emacdougall@crimson.ua	

Title of Research Project: **"Multi-method Assessment of RSTI-A and a Brief Intervention"**

Date Printed: 5/13/13 Funding Source: None

Type of Proposal: __New _x__Revision ___Renewal ___Completed ___Exempt

Attach a renewal application

a continuing review of studies form

Please enter

UA faculty or staff member signature:

II. NOTIFICATION OF IRB ACTION (to be completed by

Attach the original IRB if at the top of the page

Type of Review: _____ Full board X Expedited

IRB Action:

___Rejected
___Tabled Pending Revisions
___Approved Pending Revisions Date: IRB):

Approved—this proposal complies with University and federal regulations for the protection of human subjects.
Approval is effective until the following date: 5/23/2014

Items approved:
__X__ Research protocol: dated
____ Informed consent: dated
Recruitment materials: dated
dated

Approval signature

Date 5/24/2013