2-2020

Parent–Child Relationship, Resting Heart Rate, and Callous–Unemotional Traits in Adolescents

Eva M. Santucci
The Graduate Center, City University of New York

PARENT-CHILD RELATIONSHIP, RESTING HEART RATE, AND CALLOUS-UNEMOTIONAL TRAITS IN ADOLESCENTS

by

Eva Santucci

A master's thesis submitted to the Graduate Faculty in Cognitive Neuroscience in partial fulfillment of the requirements for the degree of Master of Science, The City University of New York

2020

PARENT-CHILD RELATIONSHIP, RESTING HEART RATE, AND CALLOUS-UNEMOTIONAL TRAITS IN ADOLESCENTS

by

Eva Santucci

This manuscript has been read and accepted for the Graduate Faculty in Cognitive Neuroscience in satisfaction of the thesis requirement for the degree of Master of Science.

Date:_____ _____

Dr. Yu Gao

Thesis Advisor

Date:_____ _____

Dr. Valerie Shafer

Associate Director

Date:_____ _____

Dr. Tony Ro

Director

THE CITY UNIVERSITY OF NEW YORK

Abstract

Parent-Child Relationship, Resting Heart Rate, and Callous- Unemotional Traits in Adolescents

By

Eva Santucci

Advisor: Dr. Yu Gao

An inverse correlation between psychopathic traits and autonomic nervous system responsiveness has been observed in various neuroscientific and psychological studies. Past research has suggested that low resting heart rate is a robust biological risk factor for a number of psychopathic traits over the course of an individual's lifetime. The reason for the link between heart rate and psychopathy is presently unknown, but it has been hypothesized that a number of other social, biological, or psychological factors, including parenting techniques, socio-economic status, and peer influences, may influence the strength of this relationship. However, further study is needed to examine specific social factors which may be of value in this relationship and which aspects of those relationships, if any might have the most impact on psychopathic traits. The goal of this study is to further explore the possible moderating effect an individual's relationship quality with parents may have on the relationship between psychopathic traits and resting heart rate in adolescents. Adolescents are a particularly relevant group in which to study this relationship, because research has shown that social relationships during childhood and adolescence have considerable potential to influence the social and behavioral development of an individual. The current study found that neither positive nor negative parent-child relationship qualities moderated the relationship between resting heart rate and callous-unemotional traits in adolescents. However, results did reveal that both resting heart rate and positive parent-child relationship qualities were negatively correlated with callous-unemotional traits in boys, while only positive parent-child relationship was significantly negatively correlated with callous-unemotional traits in girls. Implications of these findings are discussed.

Table of Contents

Tables

Figures

Introduction

Psychopathy is a term used within the fields of neuroscience and psychology to acknowledge a set of personality traits present in heightened severity among a small subset of the general population. The constellation of traits most often identified as psychopathic traits includes a mix of behavioral, interpersonal, and affective or emotional traits (Gullone, 2012; Strikland et al., 2013). Behavioral traits include risk taking and sensation seeking behavior, which may include actions such as criminal behavior or aggression towards others. Affective or emotional symptoms, which are often referred to as callous-unemotional (CU) traits, include characteristics such as lack of empathy, shallow emotions, and a flat or unemotional affect (Gullone, 2012; Kimonis, Cross, Howard, & Donoghue, 2013;). Interpersonal traits that are considered to be psychopathic in nature include grandiose, egocentric behavior, a willingness to manipulate others with little or no regard for the consequences of this manipulation, and forceful, cold-hearted actions (Lynam, 1996).

Traditionally, these traits have been grouped under disorders of varying names, including psychopathy, sociopathy, and dissocial personality disorder (American Psychological Association, 2013). However, the DSM-5 identifies the combination of affective, interpersonal, and behavioral traits discussed above into a cluster B personality disorder known as Antisocial Personality Disorder (ASPD). The fact that this diagnosis now combines several "personality" features (such as psychopathic traits) with behaviors commonly considered antisocial in nature (such as aggression and other externalizing behaviors) is important to recognize, as some studies addressed during the course of this review will refer to "antisocial behaviors" when including or discussing measures of psychopathic traits. Antisocial Personality Disorder (ASPD) is a behaviorally diagnosed psychiatric disorder which becomes applicable only after an individual reaches the age of eighteen. This disorder is marked by the behavioral, interpersonal, and CU traits described above, which may manifest as decreased concern for the safety and rights of oneself or others, disregard for social norms, aggression, chronic impulsive behavior, and the propensity to cause harm to oneself or others, among other symptoms. In order to be diagnosed with this

disorder, an individual must have displayed multiple identifying traits before or beginning at the age of fifteen, and continuing into adulthood (American Psychological Association, 2013).

While it is not appropriate to diagnose someone under the age of eighteen with ASPD, some children exhibit symptoms of this disorder and are diagnosed with conduct disorder or oppositional defiant disorder (Soderstrom, Nilsson, Sjodin, Carlstedt, & Forsman, 2005; Soderstrom, Nilsson, Sjodin, Carlstedt, & Forsman, 2014; Tsopelas & Armeniaka, 2012). Many of these children continue to show antisocial traits throughout adolescence and adulthood (Frick & White, 2008; Pardini & Loeber, 2008). The fact that a significant number of children display psychopathic traits before reaching an age where it is appropriate to be diagnosed with ASPD has led researchers to investigate the relationship between biological, social, and psychological factors present in an individual's environment and psychopathic traits throughout development, in hopes of understanding the possible causes of these behaviors. Studies have spanned a variety of associations and age ranges, with many theories being proposed to explain observed correlates of antisocial or psychopathic behaviors (Sonderstrom et al., 2005). Psychological and social factors relating to psychopathic traits in all forms have been studied in an attempt to uncover possible biological factors that may influence the development of these traits (Choy et al., 2015; Raine, 2002). These studies will be discussed in greater detail in a later section of this introduction; however, in order to effectively discuss the literature regarding environmental factors that may influence the development of psychopathic traits, it is first necessary to discuss the type of influence these factors may have. Typically, these influences designate a factor as either a protective factor or risk factor, depending on whether the factor decreases the likelihood of an individual to develop antisocial characteristics or predisposes one to them.

Protective and Risk Factors

According to Portnoy, Chen, and Raine (2013, para. 2), protective factors are defined according to the Center for Disease Control and Prevention as "… personal or social characteristics that predict a low probability of a negative outcome" on an individual's social development. Personal factors are often

considered to include biological factors, including measures of nervous system functioning (Portnoy et al., 2013). Within literature pertaining to psychopathic traits, protective factors can further be subdivided by the type of effect they have on an individual- direct protective factors have a noticeable impact on the main effect of a situation or function, whereas a buffering protective factors have a secondary impact through influence of a factor connected to a more directly influential factor. This makes buffering protective factors more difficult to study via analysis of the main effect. Additionally, a buffering protective factor is always paired with the presence of a risk factor, meaning that it reveals more about what could enhance or inhibit a risk factor's impact on a person, rather than directly impacting the trait or behavior of interest. Many researchers studying psychopathy have been interested in whether the presence of either direct or buffering protective factors would have a greater effect on the development of psychopathic traits in individuals who would otherwise be considered high risk.

Biological factors commonly considered as possible protective factors include heightened Autonomic Nervous System (ANS) response or arousal and heightened vagal tone (Portnoy et al, 2013). Studies suggest that both heightened ANS response and heightened vagal tone are likely protective factors against psychopathic traits and externalizing behavior problems (Portnoy et al., 2013). These factors have a variety of possible assessment methods, including skin conductance level and respiratory sinus arrhythmia (RSA), heart rate variability (HRV), and resting heart rate (RHR).

Risk factors, like protective factors, are defined in relation to their influence on an individual's probability of experiencing a certain outcome, and can be identified among a multitude of traits, including biological, psychological, and social factors an individual may experience over the course of their life (Portnoy et al, 2013; Raine, 2002). However, risk factors are influences that increase an individual's probability of experiencing a negative outcome. Some factors, including lower resting heart rate and heart rate variability, may serve as a risk.

As mentioned above, ANS function has been linked to psychopathic traits across multiple measures including RSA, HRV, and RHR, which each analyze separate biological processes controlled by

the ANS. The consistency of this relationship between altered ANS functioning and psychopathy scores across various measures of biological responses is worth discussion and consideration because it supports the idea that there is an autonomic underpinning that may affect an individual's predisposition to the development of psychopathic traits. The third measure of ANS response mentioned in proceeding sections, RHR, is also the measure employed by the current study to assess physiological responses in conjunction with psychopathic traits. Low RHR is regarded as a robust biological correlate of psychopathic traits because this relationship exists across a variety of biological, social, or psychological variables, such as age, social class, and IQ level (Raine, 2002). Specifically, low RHR has been implicated as a biological risk factor for a predisposition towards heightened psychopathic traits in multiple studies, and meta-analysis of these studies has supported these findings (Portnoy & Farrington, 2015). Thus, the following sections will focus on not only studies that have demonstrated the relationship between low RHR and psychopathic traits in greater detail, but also the implications of this relationship and theoretical explanations for this relationship.

Link between Low RHR and Psychopathy Across Development

Low RHR has been linked to a higher occurrence of antisocial or psychopathic traits in both childhood and adulthood (Crozier et al., 2008). Additionally, Raine (2002) found that the relationship between low RHR and antisocial traits existed after multiple other variables were accounted for, such as intelligence measured by IQ, socioeconomic status, physical activity level, body size, and gender. Similarly, a comprehensive review of studies correlating antisocial behavior, including psychopathic traits, with resting heart rate by Portnoy and Farrington (2015) analyzed both published and unpublished results from one hundred and fourteen different reports. Results showed that sex of the participants and the design of the study had no moderating effect on the association between resting heart rate and psychopathic traits. This suggests that low resting heart rate is a reliable risk factor for psychopathic traits across various demographic populations. Portnoy and Farrington (2015) also found that variables such as the number of covariates in a study or the age of the participants were unlikely to influence the effect size

of the relationship between resting heart rate and antisocial behavior. More specifically, these authors also found that the relationship between heart rate and psychopathic traits was significant under a mixed effects model. Further support for the robusticity of the correlation between low RHR and psychopathy comes from a study conducted by Raine, Fung, Portnoy, Choy, and Spring (2014), which showed that low heart rate was significantly associated with proactive aggression as well as total child psychopathy and impulsive features of psychopathy. This association was true regardless of age or gender. Furthermore, increased psychosocial adversity was a moderating factor for the effect of low resting heart rate on reactive aggression and impulsive features of psychopathy (Raine et al., 2014). The cumulative data from these studies suggest that resting heart rate is a reliable biological correlate of psychopathic traits across a variety of social and biological factors, such as age or gender.

The observed correlation between low RHR and psychopathy leads to the question of whether low RHR during childhood predicts further development of psychopathic traits in adulthood. Research has shown that various childhood-onset neuropsychiatric disorders may be predictive of adult psychopathy, including conduct disorders and oppositional defiant disorder (Sonderstrom et al., 2014; Tsopelas & Armeniaka, 2012). Research has also revealed that psychopathic traits seem to carry over from adolescence into adulthood for many individuals (Frick, Kimonis, Dandreaux, & Farell, 2003; Lynam, Caspi, Moffitt, Loeber, & Stouthamer-Loeber, 2007). Jennings, Piquero, and Farrington (2013) attempted to determine whether the association between aggressive behavior and low resting heart rate persist throughout the life of an individual, and whether there was a difference in the participant's behaviors throughout their lifetimes. Results of this study showed that a low resting heart rate was significantly associated with higher instances of involvement in violence and criminal convictions throughout the participants' lifetimes. Additionally, many of the possible protective or confounding variables assessed in the study were found to have no effect on the significance of this relationship- participants with low resting heart rates were disproportionately predisposed to violence and convictions across their lifetimes, regardless of team membership, drinking history, impulsivity, body mass index

(BMI), or childhood risk factors. This led researchers to conclude that low resting heart rate is a "significant correlate of criminal offending" (Jennings et al., 2013). Low heart rate in adolescence was also recently shown to be related to psychopathic traits at 48 years of age, indicating that this measure may be a viable predictor for behavior throughout an individual's life (Bergstrom & Farrington, 2018).

The high replicability of the relationship between low RHR and antisocial/psychopathic behavior, seems to indicate the possibility of a significant underlying reason for such a relationship (Portnoy & Farrington, 2014). However, this possibility is tempered by the fact that the relationship appears strongest for impulsive and antisocial traits and has not been observed in all individuals who exhibit psychopathic traits during adolescence (Bergstrom & Farrington, 2018). This disparity suggests that there might be moderating factors affecting the relationship between juvenile psychopathy scores and adult psychopathic traits (Lynam, Loeber, & Stouthamer-Loeber, 2008). Lynam et al. (2008) used moderated multiple regression of longitudinal data to assess whether multiple factors, including demographic data, parenting factors, and peer behaviors could influence the stability of psychopathic traits in their participants between ages thirteen and twenty-four. These authors found that delinquency of peers, physical punishment by parents, and lower socio-economic status were all factors that had the potential to lead to an increase in an individual's psychopathy scores between the ages of 13 and 24. However, these findings did not identify any factors that reduced psychopathy scores between the same ages.

Although more research is necessary to conclusively determine what that reason may be, multiple theories have been proposed to explain the association between low RHR and psychopathic traits, and the social or psychological factors that may influence them in accordance with some of the mixed findings discussed in previous section. Some prominent theories regarding the relationship between psychopathy and low RHR are discussed in greater detail in the following section, and will help to set the groundwork for understanding why social relationships, such as parent-child relationships, may be more influential on the development of psychopathic traits in individuals from one type of background as opposed to another. These theories will also help to explain the context through which individuals with psychopathic traits

perceive and respond to social relationships, and how altered ANS functioning may influence their behavior in such relationships by impairing their ability to accurately respond to social cues. Although these theories are not specifically targeted towards explaining psychopathy in children or adolescents, they are not incompatible with a developmental viewpoint, and thus will be applied within the context of an adolescent population in the current study.

Theories Regarding RHR and Psychopathy

A possible explanation for the relationship between low RHR and antisocial traits, called the stimulation-seeking theory, concerns the experience of arousal in individuals with low RHR. The stimulation-seeking theory posits that individuals with low RHR may be more likely to display antisocial traits because they experience low arousal in daily lives, which results in an unpleasant state of being. Thus, these individuals are driven to increase their arousal in an attempt to reach a more pleasing physical state. In this way, a lower heart rate may cause an individual to seek heightened arousal through any means necessary, including thrill-seeking and risk-taking behaviors. While the behaviors that individuals find stimulating may be benign in some cases, but they may also be acts that society deems deviant, including criminal behavior such as burglary, assault, or robbery (Raine, 2002). This theory fits well with the results reported by Jennings et al. (2013), which concluded that low resting heart rate is a "significant correlate of criminal offending" and suggested that low RHR might actually be a biological underpinning of such behavior patterns. Additionally, Portnoy et al. (2014) found that a significant association exists between antisocial behaviors, including psychopathic traits, and low heart rate in line with the findings of previous studies in this field. These researchers also found that while fearlessness did not have a significant effect on the relationship between antisocial behavior and low heart rate, sensation-seeking was a mediating factor in that relationship (Portnoy et al., 2014). This finding supports the proposition that sensation-seeking may be an underlying factor for antisocial behavior in individuals with low heart rates.

Stimulation-seeking theory is complemented by another theory, called fearlessness theory, which concerns the emotional responses that might be evoked in people with low RHR, and how the perception of these emotional responses might affect behavior. Fearlessness theory suggests that the low arousal levels indicated by low RHR may actually be caused by an absence of or decreased experience of fear. Proponents of this theory argue that the heart rate measured in a laboratory session is not actually "resting", but rather represents a heart rate measurement taken during a mildly stressful paradigm. Therefore, people with low RHR should be said to display lower than average heart rate even in the midst of a mildly stressful situation, such as having one's heart rate recorded as part of a laboratory study. This could indicate that the individual experiences less anxiety or fear than others might in a similar situation, which causes them to have less physiological response to stress, and thus, a lower heart rate. If this is true, then these individuals may be predisposed to psychopathic traits (particularly of the callous-unemotional variety), because they experience less fear in other social situations, as well- which could lead them to have less regard for the punishment or social isolation which typically befalls those who engage in deviant behavior as adults (Raine, 2002). As stated above, this theory is considered to be complementary to stimulation-seeking theory in the sense that while a lack of fearfulness may predispose an individual to commit a criminal or violent act, the heightened arousal produced by the experience may serve as a reinforcer for future antisocial behaviors and expression of psychopathic traits. Thus, the two theories may be more valuable for explaining the relationship between low RHR and psychopathy in terms of their cumulative effect on individuals than through the influence of either theory on its own (Raine, 2002).

Social Push Theory

One proposed theory suggesting a moderating effect of social and biological risk factors on psychopathic traits is the social push theory. The social push theory suggests that physiological factors like low RHR are more likely to explain the development of psychopathic traits only in individuals who do not also experience social factors that predispose them to such traits. Simply put, antisocial traits and low RHR may be linked in a way that causes a significant, observable effect only in the absence of other

social or psychological factors which may serve to obfuscate the existence of this relationship. This does not mean that the actual degree to which a person from a benign background displays low RHR and aggressive traits is more significant than it would be in someone from an adverse home environment or low socioeconomic status. It simply means that the relationship is more easily observed in these individuals because other factors such as social causes of aggressive behavior are not present, which allows the influence of biological factors like RHR to be observed in the absence of social confounds. For example, Raine (2002) looked at a number of different examples of biosocial interaction effects, hoping to determine which effects were significant in influencing the formation of antisocial behaviors, including psychopathic traits, in children and adults. Analysis of 39 empirical studies on different interaction effects, with variable of interest being treated both as outcome variables and as grouping variables for a variety of conditions, showed two main themes. First, when social and biological risk factors were treated as grouping variables and the outcome variables were antisocial behaviors, the presence of both grouping variables exponentially increased the likelihood of antisocial behaviors. Secondly, when the grouping variables were antisocial and social behaviors, researchers observed that the relationship between antisocial behaviors and biological risk factors was always moderated by the presence of social factors (Raine, 2002). These findings are in line with the social push theory insofar as they suggest that low RHR was a stronger characteristic of antisocial behavior among individuals from higher socioeconomic backgrounds who had not encountered traditionally viewed triggers for the development of psychopathic traits, such as being a victim of violence or experiencing parental absence or neglect. This theory is important within the context of the current study because it acts as sort of bridge between psycho-social and neurobiological views of psychopathy. More precisely, this theory suggests that social factors, including either positive or negative aspects of parent-child relationship, could act in conjunction with biological risk factors to influence the development of psychopathic traits, but that this influence would be most easily observed in individuals without other environmental risk factors, which explains the mixed findings in regard to low RHR and psychopathy in previous studies.

Social factors: Parent-child relationship

Though the aforementioned theories may attempt to include social factors as possible covariates of the relationship between low RHR and psychopathy, they fail to entirely account for the influence of social relationships on personality formation. Relationships with both parents and peers are crucial for social development during adolescence and may influence a variety of traits, including interpersonal skills, motor functioning, and cognitive development (Collins & Laursen, 2004). Other researchers have suggested, based on longitudinal analysis of stability in psychopathic traits among children, that social relationships in general may be a point of intervention for children with psychopathic traits (Barry, Barry, Deming, & Lochman, 2008). With this in mind, it seems possible that the influence of parental relationships during adolescents could moderate the effect of other biological, psychological, or social risk factors on an individual's chances of developing psychopathic traits. In support of this assumption, researchers interested in the relationship between adverse social factors and physical aggression trajectories in adolescents found that less parent-child bonding and lower parental control was correlated with increased instances of physical aggression, and with higher initial levels- and increased instances over time- of social aggression (Karriker-Jaffe, Foshee, Ennett, & Suchindran, 2013). Additionally, Cabrera, Herrera, Rubalcava, and Martínez, (2017) found that higher levels of eye contact during conversations and use of open ended questions in social relationships, including parent-child dyads, were likely protective factors for engagement in antisocial behavior among adolescents.

The idea that parent-child relationships may be a moderating factor for psychopathic traits specifically has been proposed by a number of studies. For instance, Dadds, Jambrak, Pasalich, Hawes, and Brennan (2011) found that male children high in callous-unemotional (CU) traits showed impairment in making and maintaining eye contact with both parents. While the mothers of these children showed no reciprocating impairments in eye contact, eye contact with the fathers was impaired in correlation with the impairment exhibited by the child. This lack of eye contact may be a characteristic trait of male children with high psychopathy scores (Dadds et al., 2011). Additionally, in a follow up study, Dadds et al. (2012)

compared the behavior of children diagnosed with oppositional defiant disorder who were high in CU traits to those of a control group of peers. They found no difference in the behavior of mothers in regard to either population; all expressed affection for their children equally. However, children with oppositional defiant disorder were less affectionate towards their mothers in return, and children who specifically ranked high in CU traits were not only less expressive to their mothers, they also showed inhibited eye contact in line with the findings of the previous study. This suggests that children who are higher in CU traits may have a lower propensity for assessing other peoples' facial expressions, which could inhibit their ability to experience empathy for others and to form normal social connections, including forming typical connections with their own parents (Dadds et al., 2012). Additionally, Silva and Stattin (2016) found that parental knowledge of their children's behaviors and child willingness to disclose information were both linearly related to the severity of antisocial behavior, suggesting that positive qualities in parent-child relationships are a possible buffering protective factor for children who are at risk of developing antisocial and psychopathic behavior.

Other studies have suggested that parenting may contribute to specific subsets of psychopathic traits. For instance, Lopez-Romero, Romero, and Villar (2012) found that parenting style, as well as socialization with parents, was significantly correlated with CU and behavioral measures of psychopathic traits in children between 6 and 11 years of age. More specifically, these researchers found that strong communication between parents and children (e.g. the use of dialogue to reason through conflicts, rather than putative measures) was particularly important in facilitating emotional development (Lopez-Romero et al., 2012). Similarly, Buck (2015) found that maternal sensitivity to children's needs acted as a protective factor for male children with poor inhibitory control. Males participants who had higher maternal sensitivity scores were less likely than similarly inhibitory control-challenged peers to develop psychopathic traits, indicating that maternal sensitivity may act as a protective factor in male children who are otherwise at a high risk of developing psychopathic traits (Buck, 2015). This study also found that while maternal sensitivity did not directly mediate the relationship between psychopathic traits and

inhibitory control, it was related to attachment style, such that higher rates of maternal sensitivity were correlated to secure attachment among girls. This is important because secure attachment was associated with reduced development of psychopathic traits in adolescent girls with low inhibitory control. Kimonis et al. (2013) also found that maternal relationships among youths with psychopathic traits influenced the quantity and dimensions of psychopathic traits, and specifically, CU traits. These researchers found that adolescents who had lower maternal care were more likely to display a high amount of CU traits. In turn, there was an interaction between levels of maternal care and CU traits, whereby individuals scoring high on CU traits and who received low maternal care were more aggressive than their counterparts who had high maternal care (Kimonis et al., 2013). Additional research has found that while children with CU traits showed acute impairments in context-sensitive emotion regulation they do not, as previous studies have suggested, show less sensitivity to parental influence than their peers (O'Connor, Humayun, Briskman, & Scott, 2016). Taken together, these studies suggest a developmental component to psychopathic traits, which may be influenced at least in part by a child's attachment to caregivers. This possible influence of parental relationship with psychopathic traits could explain the discrepancies found by previous studies regarding the relationship between low RHR and development of psychopathic traits. However, many of the aforementioned studies assessed parenting effect on psychopathic traits using only measures of either positive or negative parenting characteristics, or using observational data collected while parents and children were observed in a controlled setting. This may result in an incomplete picture of the effect that parent-child relationship as a whole may have on the development of psychopathic traits, especially in children who may already be predisposed to development of these traits by either social or biological risk factors. In an attempt to account for the influence of both positive and negative aspects of the parent-child relationship, the current study utilizes two separate measures of parent-child relationship quality, one of which measures parent-child relationship quality over all, and one that has subscales to assess positive and negative relationship aspects separately.

The Current Study

The goal of the current study was to determine the association between parent-child relationship quality, low resting heart rate, and development of psychopathic traits in adolescents. Based on the literature reviewed above, it was hypothesized that interpersonal relationships might act as a moderator on the relationship between psychopathic traits and low RHR, such that individuals with low RHR who have strong, high quality interpersonal relationships with parents will display a lesser degree of psychopathic traits than individuals who experience both low resting heart rate and poor interpersonal relationship quality with parents.

Method

Participants

The sample for this study consisted of one hundred and one 13 to 16 year old boys and girls (mean age= 14.39) who were recruited as part of the Healthy Childhood Study (HCS). The HCS is an ongoing longitudinal study assessing the biological, social, and psychological factors influencing child development, specifically in regard to antisocial traits or behaviors. Eligibility to participate in this wave of the study was based on participation in previous waves, and participants were contacted for recruitment via phone calls or email. All participants lived in Brooklyn, New York or a surrounding area during the time of their participation in the study. Initial interviews to determine participant eligibility were conducted over the phone and included screenings for previously diagnosed psychiatric disorders or prescription of medications, enrollment in therapy, or intellectual or behavioral disorders. A parent or legal guardian needed to be willing to come in with participants, and was also expected to provide questionnaire and behavioral data about the participant. Caregivers in attendance at sessions were predominantly mothers, although fathers and other legal guardians such as grandparents were represented in the sample as well.

Procedure

Participants and primary caregivers were asked to attend sessions at Brooklyn College where physiological data was recorded, and demographic and behavioral data was obtained. Some participants chose to complete social risk factor assessments and demographic data questionnaires at the time of the session, in which case questionnaires were provided to the participant and caregiver upon arrival to the lab. Other caregivers asked to receive both the parent and child questionnaires via email, and the caregiver and child completed the questionnaires elsewhere before bringing them to the session. Data collected via questionnaires includes the Network of Relationship Inventory- Relationship Qualities Version (NRI-RQV) and the Social Support Questionnaire for Children (SSQC).

Questionnaires were presented in the same order and participants were given the opportunity to clarify their understanding of the questions at the time of their session. All surveys were checked for completeness at the end of the session and all interview data were collected by graduate-level research assistants trained by the principle investigator. Psychophysiological data were monitored by research assistants as they were collected. Participants were given monetary compensation for their participation in the study, and both caregiver and child consent were obtained and reviewed prior to each session. All study procedures and materials were approved by the CUNY IRB.

Measures

Network of Relationship Inventory- Relationship Qualities Version (NRI-RQV)

The NRI-RQV is one of three variations of the Network of Relationships Inventory (NRI) developed by Furman and Buhrmester (1985). The NRI as a whole was designed to assess characteristics across a variety of interpersonal relationships. Participants are asked to use the same scale to rate aspects of their relationships with a multitude of people, including friends, family members, and people they are in a romantic relationship with. The questionnaire covers positive, negative, and 'other' qualities, although different versions may emphasize different qualities from each category, and not all traits are present on all versions (Furman and Buhrmester, 1985). This method of scoring allows for analysis of

average differences between types of relationships, profiling of qualities in various relationships based on combinations of characteristics, and evaluation of individual differences of relationship qualities. The NRI-RQV follows these conventions, but this version of the questionnaire is based more on observable behavioral measures of relationship quality, and as a result it measures traits in terms of their frequency (how often something occurs in a relationship) rather than their magnitude (how much something happens). Furthermore, the NRI-RQV assesses a more diverse assortment of relationship qualities between child, adolescent, and adult relationships. This includes negative traits such as exclusion, pressure, dominance, conflict, and criticism, as well as positive traits like approval and emotional support (Furman & Buhrmester, 1985). The NRI-RQV has thirty questions, with ten sub-scales comprised of three questions each. The five positive subscales are companionship, intimate disclosure, satisfaction, emotional support, and approval. The five remaining subscales evaluating negative traits are exclusion, criticism, dominance, pressure, and conflict/quarreling. Participants rate how frequently each trait occurs in their relationships with various people, such as their parent/legal guardian, their sibling(s), friends of the same or opposite gender, and a significant other. The participants respond using a 5-point Likert-scale, where a response of 1 means "Never/Hardly at All" and 5 means "Always/Extremely Much". Scores for each subscale are obtained by averaging the scores across all three questions in the subscale. For each relationship, scores for positive and negative scales themselves can be found by obtaining a sum of all subscale scores assessing traits with either positive or negative values. The current study analyzed mother and father relationships scores.

The NRI-RQV is sensitive to gender differences and developmental differences in relationships as people age from childhood to adulthood (Furman & Burhmester, 1992), making it an ideal measure for our adolescent sample. Our Cronbach's alpha values for this measure were .923 and .776 for scores of mother closeness and discord, respectively, with similar values for father closeness (.946) and discord (.781). These values indicate an acceptable to excellent level of reliability for both subscales.

The Social Support Questionnaire for Children (SSQC)

The Social Support Questionnaire for Children is a 50 item self-report measure designed to assess the support children receive from their social networks via five categories: Non-relative adults, relatives, parents, siblings, and peers. These relationships are quantified by asking participants to answer questions using a 4-point Likert-scale ranging from 0-3, with the numbers standing in for responses of "Never or rarely true", "Sometimes true", "Often or very true", and "Always true". An overall score may be compiled by adding the sum of all responses, while subscales can be assessed by attaining the sum of responses for each item in a subscale (Gordon, 2011). Additionally, scores for each category can be obtained either in full or by assessing only certain subscales, and the flexibility of categories (such as "non-relative adults") allows researchers to ask about a broad range of authority figures or interpersonal relationships in a child's life. The current study focuses on the parent subscale only.

The SSQC provides a psychometrically sound method for assessing children's social support, as it has been found to have high concurrent and convergent validity, as well as acceptable construct and factorial validity (Gordon, 2011). Furthermore, analysis by Gordon (2011) displayed high internal validity across all 50 items of the questionnaire, as well as all 5 subscales. Cronbach's alpha for this measure in the current sample was .949.

Inventory of Callous-Unemotional Traits (ICU)

The ICU is a 24-question survey used to assess callous-unemotional traits in children and adolescents. Comprehensive assessment of these traits is necessary in order to discern between antisocial and aggressive youths, whose behavioral disorders may have other symptoms that overlap. The questionnaire can be taken as a self-report measure but has an additional four forms: a parent-report version, a parent-report (preschool) version, a Teacher report, and Teacher report (preschool) versions. On these versions of the measure, adults are asked to describe how well a statement describes the child's behavior by rating the statement's accuracy on a 4 point Likert-scale. The scale ranges from 0= Not at all true, 1= somewhat true, 2= very true, 3= definitely true. Regardless of the versions, the ICU has three subscales: the Callousness, Unemotional, and Uncaring subscales. Subscale scores are calculated by

obtaining the sum of responses for each answer within that subscale, while a cumulative score was calculated by combining the scores for all three subscales. The ICU has been successfully implemented in order to study callous-unemotional traits in children in a variety of studies (Frick et al., 2003; Fagan, Zhang, & Gao., 2017; Ciucci, Baroncelli, Franchi, Golmaryami, & Frick, 2014). For the purposes of this study, and in accordance with the suggestion of Frick (2004), a maximum ICU score was derived by combining both parent-report and self-report data by taking the larger score reported for any item. Cronbach's alpha values for the total ICU scores calculated in this sample were .788 for self-report data, and .842 for parent-report data.

Psychophysiological Data Acquisition and Analysis

All physiological data were obtained using a BIOPAC MP150 system (Biopac Inc., CA). Since the purpose of the current study included an analysis of resting heart rate, rest-period data collected during a two-minute rest period at the beginning of the physiological data collection session was analyzed. At the onset of data acquisition for each session, participants were asked to sit as still and as quietly as possible, while focusing their attention on a fixation point presented on a computer screen in front of them.

Analysis of RHR was completed offline, using Kubois HRV software (version 2.2, Tarvainen, Niskanen, Lipponen, Ranta-aho, & Karjalainen, 2014). Electrocardiography (ECG) signal was collected via ECG100C using two pre-gelled Ag-AgCl disposable vinyl electrodes placed in a variation of a Lead II configuration. Prior to each data collection session, and before attaching electrodes, research assistants cleaned the areas to which electrodes would be affixed with NuPrep gel. Initial readings from this system were visually reviewed by a trained graduate-level research assistant to correct for false or undetected R-waves, ectopic beats, or possible movement artifacts, as well as to confirm appropriate strength of the ECG signal being recorded. RHR was calculated by averaging inter-beat interval and was measured in beats per minute (bpm). RHR data included in the final analysis was recorded during the two-minute rest period before the participant began computerized activities requested for the study.

Missing Data

Missing values in the data set were replaced using mean substitution for subgroups. In this analysis, subgroups were defined by the subscale for each measure, such that all means were calculated using only an individual's scores of other items on whichever subscale the means were being substituted into. Mean substitution for subgroups is a statistically superior technique to simple substitution of the mean, as defining subgroups before calculating individual mean scores allows for an estimate which is more likely to be an accurate reflection of the responses within that subgroup, and maintains more variance within the data than simply substituting in one mean for all items measured (Acock, 2005).

Statistical Analysis

All statistical analysis was conducted through SPSS 22.0 and 23.0. A moderated multiple regression analysis was determined to be an appropriate statistical method to use in order to determine whether or not parent-child relationship quality had a significant moderating effect on the relationship between RHR and psychopathic traits in adolescents. This method of analysis allows for control of or inquiry about a variety of different factors included as either variables of interest or as covariates in this study. These factors were age and gender of participants, quality of relationship with parents, and the participant's RHR level.

Prior to analysis, a principle components analysis (PCA) was performed on the NRI-RQV and SSQC data. Results of the Kaiser-Meyer-Olkin Measure of Sampling Adequacy was within an acceptable range (.646), while Bartlett's Test of Sphericity had a significant p-value ($p<.001$), indicating that PCA was an appropriate technique to use on the current dataset. The results of the PCA showed that Factors 1 and 2 account for 79.638% of the variance between components, with a scree plot of the eigenvalues "leveling off" after factor 1 and factor 2 scores (Figure 1). Further investigation of the component matrix (Table 2) showed that NRI-RQV subscale scores for both mother and father closeness and SSQC parent subscale scores, which measures positive qualities, were positively loaded onto Factor 1. Both mother and

father discord subscales on the NRI-RQV, however, were loaded positively onto Factor 2. Both factors were retained for analysis, with Factor 1 being used to evaluate positive parent-child relationship qualities and Factor 2 being used to evaluate negative parent-child relationship qualities.

Resting HR scores and age were centered to correct for possible collinearity between variables prior to analysis. Correction for multicollinearity was not necessary for either positive or negative factor scores, or for gender, which was already dummy coded. Interaction terms for all multiple regression analyses were calculated using factor scores and centered resting HR scores. Centering and creation of interaction scores was conducted in accordance with the suggestions of Aiken and West (1991).

A moderated regression analysis testing positive parent-child relationship quality as a moderator for the relationship between low RHR and psychopathy was conducted. For this analysis, ICU scores were used as the dependent variable, while both age and gender were included in the initial block (block 1) as predictor variables to account for any covariate effects. In the second block mean RHR and factor 1 scores (positive parent-child relationship qualities) were included. In the third block, the interaction term previously created between mean RHR and parent-child relationship quality was added.

Next, a moderated multiple regression analysis testing negative parent-child relationship quality as a moderator for the relationship between low RHR and psychopathy was conducted. For the first block of this analysis ICU score was again used as the dependent variable while both age and gender were included as predictor variables. In the second block mean resting HR and factor 2 scores (negative parent-child relationship qualities) were included. In the third block, the interaction term previously created between mean RHR and negative parent-child relationship quality was added to the model.

Finally, two separate moderated multiple regression analyses were conducted for each gender group, in order to investigate whether the above effects differed between boys and girls. An independent t-test was used to assess mean differences in physiological data between the two groups.

Results

Positive Parent-Child Relationship Quality

Results of the hierarchical regression analysis are shown in Table 4. In step 1, gender and age cumulatively accounted for 0.9% of variation in CU trait scores (R^2= .009, F(2, 89)= .388, p=.680). When RHR and positive parenting scores were added in step 2, the model accounted for 20.9% of variation in CU traits (R^2= .209, F(2, 87)= 11.025, p=.000). The addition of the RHR X positive parenting score interaction term in step 3 did not significantly increase the proportion of variation in CU traits accounted for by the model (R^2=.211, F(1, 86)=.172, p=.679), indicating no moderating effect of positive parenting on the relationship between RHR and CU traits.

Negative Parent-Child Relationship Quality

Results of the hierarchical regression analysis are shown in Table 5. In step 1, gender and age cumulatively accounted for 0.9% of variation in CU trait scores (R^2= .009, F(2, 89)= .388, p=.680). When RHR and negative parent-child relationship quality scores were added in step 2, the model accounted for 2.2% of variation in CU traits among the adolescent participants of the study (R^2= .022, F(2, 87)= .591, p=.556), which was not significant. The addition of the RHR X negative parent-child relationship quality interaction term in step 3 did not significantly increase the proportion of variation in CU traits accounted for by the model (R^2=.041, F(1, 86)=1.722, p=.193), indicating no moderating effect of negative parent-child relationship quality on the relationship between RHR and CU traits.

Positive Parent-Child Relationship Quality: Boys

Results of the hierarchical regression analysis are shown in Table 6. Among male participants, age accounted for 0.8% of variation in CU trait scores (R^2= .008, F(1, 38)= .317, p=.577). When RHR and positive parent-child relationship quality scores were added in step 2, the model accounted for 23.4% of variation in CU traits among the adolescent participants of the study (R^2= .234, F(2, 36)= 5.305, p=.010). The addition of the RHR X positive parent-child relationship quality interaction term in step 3 did not significantly increase the proportion of variation in CU traits accounted for by the model

(R^2=.250, F(1, 35)=.746, p=.394), indicating no moderating effect of positive parent-child relationship quality on the relationship between RHR and CU traits.

Positive Parent-Child Relationship Quality: Girls

Results of the hierarchical regression analysis are shown in Table 7. Among female participants, age accounted for 2.2% of variation in CU trait scores (R^2= .022, F(1, 50)= 1.139, p=.291). When RHR and positive parent-child relationship quality scores were added in step 2, the model accounted for 27.7% of variation in CU traits (R^2= .277, F(2, 48)= 8.464, p=.001). The addition of the RHR X positive parent-child relationship quality interaction term in step 3 did not significantly increase the proportion of variation in CU traits accounted for by the model (R^2=.277, F(1, 47)=.018, p=.892), indicating no moderating effect of positive parent-child relationship quality on the relationship between RHR and CU traits.

Differences by Gender

An independent-samples T-Test was used to compare RHR in boys and girls (Table 8). There was no significant difference between boys (M=75.73, SD=11.18) and girls (M=79.28, SD=11.25), t(97)=-1.565, p = .121. This indicates that the observed correlation between RHR and psychopathic traits in boys but not in girls was not likely due to a significant difference between mean RHR of the two genders.

Discussion

This study examined the moderating effects of parent-child relationship quality on the relationship between decreased ANS response and development of psychopathic traits in adolescents. It was hypothesized that individuals with low RHR but high-quality parent-child relationships would show fewer psychopathic traits than individuals with low RHR and poor parent-child relationship quality. Results of the current study did not support this hypothesis; there was no statistically significant moderating effect for parent-child relationship quality on the relationship between RHR and psychopathic traits in adolescents. However, analyses did reveal that positive parent-child relationship were correlated to psychopathy scores in general, which supports existing literature suggesting that positive parenting

behaviors may be more effective for influencing social development of children with CU traits. Additionally, the fact that RHR correlated with psychopathy scores in boys, but not in girls provides support for the proposition that boys may be more sensitive to the effect of biological risk factors, such as low RHR, than girls are or that there may be gender differences in socialization or genetics which influence the effect of biological risk factors on psychopathic traits. Current findings further support the biopsychosocial view of psychopathy, which suggests that familial relationships may be only partially adequate to explain the development of psychopathic traits in children, with social, environmental, and genetic factors accounting for some of the variation in development of these traits.

Positive Parent-Child Relationship Qualities

The results of this study indicate that in both boys and girls, the occurrence of positive parent-child relationship quality was more influential on overall psychopathy scores than the presence of negative parent-child relationship quality, which were not found to be significantly correlated to CU either in the sample as a whole or among either gender group. This is in line with previous research which found that positive parental relationship qualities were particularly effective in developing a sense of empathy and consciousness among children, and that positive parent child relationship qualities can act as protective buffers against risk factors for psychopathic traits (Hoffman, 1983; Lepper, 1981; Maccoby, 1983; Waller et al., 2016). The current study expands these findings by suggesting that positive parent child relationship quality may continue to have an effect on CU traits, even into adolescence.

Because many measures of positive parent-child relationship quality assess aspects of behavior that include modeling good, prosocial behaviors to their children, children high in CU traits who regularly see such behaviors being modeled, in turn, may be more likely to be able to replicate these behaviors appropriately than antisocial peers who do not see these behaviors modeled. This is in line with the suggestions of Clark and Frick (2018), who showed that among preschool children with CU traits, three positive aspects of parenting (parental warmth, positive reinforcement, and parent-child cooperation and communication) were all negatively correlated with CU traits to a significant degree, although only

parental warmth continued to have a significant correlation after the severity of CU traits was controlled for. These authors suggest that parental warmth may be a particularly important factor on the development of CU traits because it may provide modeling for the development of empathy, guilt, and other prosocial emotions, which children who are predisposed to fearlessness may not develop as readily through typical social interactions with others. This is further supported by a study of the interaction between fearlessness traits and parenting conducted by Waller, Shaw, and Hyde (2017), who found that fearlessness among children at age 24 months predicted later levels of CU traits only in children who also had parents who scored low on measures of positive parenting. These authors also found that low positive parenting could indirectly predict CU traits at 10-12 years of age, but that this relationship was again moderated by fearlessness (Waller et al., 2017). Similarly, maternal parenting has been shown to be correlated with psychopathic traits such that maternal and child psychopathic traits were associated with each other only in dyads where positive parenting was low or absent (Robinson, Azores-Gococo, Brennan, & Lilienfeld, 2016).

There is also the possibility that positive parent-child relationship qualities are also simply more likely to be motivating for children with CU traits than are qualities which could be qualified as negative parenting traits, and therefore are more likely to be effective parenting techniques for these children. For instance, studies of parenting behavior by developmental psychologists have long indicated that the interaction between fearlessness, or a child's temperament in general, and parenting style is complex and may not have a single universally applicable process (Collins, Maccoby, Steinberg, Hetherington, & Bornstein, 2000; Eisenberg, 2006; Rothbart & Bates, 2006). Previous studies have shown that deficits in fear are linked to psychopathy, and that children who have a deficit in fear experience insufficient anxiety to gentle discipline, meaning that they fail to attend to parental cues or to changes in behavior (Blair, 1995; Fowles, 1988; Frick & Morris, 2004; Lykken, 1995). However, increasing the harshness of discipline in order to correct for this failure to attenuate has also been shown to be ineffective, with studies finding that when harshness of discipline for children who fail to attenuate to caregiver demands

due to lack of fear is increased, the result is often anger, externalizing behaviors, and insufficient processing of parental messages (Hoffman, 1983; Lepper, 1981; Maccoby, 1983). These studies seem to fit best with the fearlessness theory of psychopathy, suggesting that children who score high on measures of psychopathic traits may be less afraid of punishment or may not have the same physiological response to parental anger and disappointment as children who are low on CU traits. In response to this, Kochanska (1993) proposed a multiple pathways to conscience model, suggesting that differences in child temperament may be pivotal to determining which parenting style is most effective in encouraging the development of a strong moral conscience. Given the evidence that harsh parenting is less effective among children with deficits in fear, this model suggests that in such children, intervention strategies which emphasize capitalizing on positive parenting aspects, including a reciprocal, positive parent-child relationship may be most effective. Positive parent child relationship qualities have been shown to positively influence development of conscience, improve socialization outcomes overall, and encourage the development of a sense of empathy (Maccoby, 1983). Findings by Kochanska, Aksan, and Joy (2007) suggest that among fearless children, positive relationship qualities with mothers predicted good socialization outcomes, while displays of power in parenting by fathers predicted negative socialization outcomes. When focusing specifically on children with CU traits, previous studies continue to suggest that children high in CU traits respond better to rewards than to punishment (Fisher & Blair, 1998; Frick et al., 2003; O'Brien & Frick, 1996), which suggests the continued relevance of parenting style as an influence on the development of psychopathic traits. This also supports the suggestion of Clark and Frick (2018) that parents' use of positive reinforcement may be particularly influential among children with CU traits. The current study contributes to this body of literature by extending these findings to an adolescent population, and by using child-report measures of positive qualities in relationships, rather than parent-report or observational data.

Gender Differences

Buck (2015) argues that differences observed between genders with respect to the influence of parenting style on psychopathic traits may be in part due to differences in socialization. While males are typically socialized to value independence and autonomy, females tend to be socialized to value family and social connections. This could result in women valuing relationships more highly than males, which could alter the emphasis they place on regulating antisocial or callous behaviors. This theory is in line with the findings of Padilla-Walker and Nelson (2010) who demonstrated that female adolescents tended to value maternal connection more highly than their male counterparts. The results of the current study seem to be in line with this theory, as the correlation between positive relationship qualities and psychopathic traits had a stronger statistical significance among girls ($p<.001$) than among boys ($p=.012$).

While heart rate was not significantly correlated with CU traits in girls, a significant negative correlation between RHR and CU traits was found in male participants. This is in line with previous literature that has asserted that males may show a higher susceptibility to biological risk factors for antisocial behavior or psychopathic traits than females do. For example, Sadeh et al. (2010) suggest that certain genetic polymorphisms related to serotonin transporter protein gene (SLC6A4), in conjunction with environmental factors, may predispose males to CU and narcissistic traits, but this finding has not been demonstrated in females. In regard to ANS functioning specifically, Zhang et al.'s (2017) findings of RHR mediating the relationship between antisocial behaviors and social adversity in male participants but not females indicate that gender influences the interaction between biological and sociological risk factors for antisocial behaviors, including psychopathic traits. Sijtsema et al. (2010) found that low RHR was associated with aggression and decreased regard for rules in boys, but not girls. The authors suggest that this could mean that the relationship between antisocial behavior and RHR is dependent on a number of other factors, including age, gender, and the type of antisocial behavior. The findings of the current study support this suggestion, but build upon the findings of Sijtsema et al. (2010) by demonstrating that RHR may also be correlated to CU traits, in addition to aggression and rule breaking, among adolescent males.

It is also interesting to note, in light of the current study's finding that RHR was negatively correlated to CU traits in boys, that one study assessing the interplay between parent-child relationship and fearlessness in children found differing manifestations of fearlessness between genders; while girls showed more fearlessness in relation to novel situations and danger, fearlessness in boys manifested as a decreased response to punishment (Barker et al., 2011). Given the findings of the current study, in combination, it seems reasonable to suggest that boys with CU traits may be particularly likely to show a decreased response to punishment because as suggested by the fearlessness perspective, they have reduced ANS activity that causes them not to experience the typical anxiety response evoked by punishment. If this is true, then this study's findings that there was no correlation between RHR and CU traits in girls could also help explain why female participants in the Barker et al. (2011) study did not show a reduced response to punishment, and manifested fearless behaviors in other ways. For female participants, ANS response to punishment would have been more similar to their peers without CU traits, meaning that they would experience optimum anxiety in response to punishment, which would allow them to more effectively internalize the messages associated with the punishment (Hoffman,1983).

Heart Rate and Callous Unemotional Traits

This study provides evidence that ANS activity is correlated with psychopathic traits specifically, and not simply as a corollary of a possible relationship between ANS and antisocial behavior. One criticism of previous literature regarding ANS function and psychopathic traits is that "there has been significantly less research examining the relationship between heart rate and psychopathy than has examined heart rate and antisocial behavior generally", which may have made led to researchers to have an incomplete picture of the relationship between RHR and psychopathy specifically, as opposed to antisocial behavior as a whole (Kavish, Fu, Vaughn, Qian, & Boutwell, 2019b, para. 6). Kavish et al. (2019b) further assert that to date, there has been "a lack of research focusing on the relationship between physiological variables and psychopathic personality features" (para. 7). However, the current study avoided this issue by measuring only CU traits and found that there was a correlation between RHR and

CU traits in male participants, indicating at least some support for the idea that low ANS functioning may be linked to psychopathy, either in addition to or independent of its link to antisocial behavior. While there is certainly need for more study of various subtypes of psychopathic traits and their relation to behavioral risk factors, this finding suggests that it would be erroneous to entirely disregard the relationship between ANS function and psychopathic traits as a result of the connection between psychopathic traits and antisocial behavior at this time.

The current study further contributes to current knowledge within the field by supporting previous findings of an inverse relationship between RHR and psychopathic traits among male participants. Recent literature has suggested that previous studies observing the relationship between RHR and psychopathy may have been unreliable because studies have often had small sample sizes, used forensic populations, failed to account for gender differences, and dichotomized their samples into either "psychopathic" or non-psychopathic traits (Kavish et al., 2019a). Kavish et al. (2019a) further claim that after controlling for multiple comparisons, gender, age, and race, they found little support for any association between autonomic nervous system activity and psychopathic traits. However, the current study also utilized a non-dichotomous measure of psychopathy among a non-forensic population and controlled for gender differences by running separate comparisons and using T-tests to assess mean heart rate for both genders. This study found that there was a significant correlation between RHR, a measure of ANS activity, and CU traits. Thus, the findings of this study support previous studies which report correlations between ANS activity and measures of antisocial behavior or psychopathy. Specifically, this study suggests that there were not significant mean differences between RHR in boys or girls which would account for the fact that RHR was significantly correlated with psychopathy in males, and that use of a sample of individuals outside of the forensic population does not alter the findings of a correlation observed between RHR and psychopathy in previous studies. It is possible that the difference in results between Kavish's (2019a) study and the current study could be due to the age of participants; while the current study used adolescent participants, Kavish (2019a) assessed ANS functioning among

undergraduate students, meaning that participants were in very late adolescence/early adulthood. It may be possible that age and RHR interact in such a way that the relationship between low RHR and psychopathic traits is more observable during childhood and adolescence than during young adulthood. Again, it is worth mentioning the conclusions of Sijtsema et al. (2010), who suggest that the association between RHR and antisocial behavior depends on age, gender, and subtype of antisocial behavior being studied.

Parent Psychopathy

One other factor not covered in the current study that could have affected the interaction between parent-child relationship quality and psychopathy is psychopathic traits in parents. Previous studies have shown that parent psychopathic traits may be correlated with psychopathic traits in their offspring, suggesting that genetic or social influence of such parents may predispose an individual to psychopathic traits. In line with this idea, Moffit (2005) found that associations between parent-child communication and development of callous interpersonal traits may be more related to shared genetics between parents and their offspring, as opposed to parenting style. This concept is further supported by the results of Viding et al. (2005), which demonstrated that parental genetics may account for extreme levels of antisocial behavior in monozygotic twins, as well as with meta-analyses that have shown that genetic factors can explain between 40% to 50% of variation in antisocial behavior over the total population (Miles & Carey, 1997; Rhee & Waldman, 2002). All of these findings suggest a significant possibility for antisocial behavior, including psychopathic traits, to be present in more than one member of a family or even in more than one member of the parent-child dyad. Concurrently, Dadds et al. (2011) found that lack of eye contact among toddlers with CU traits was correlated with the fathers who also displayed CU traits, even when mothers made attempts to engage the child in eye contact and had no such antisocial traits themselves. Shared environment effects among family members are also stronger for conduct disorder, which is a necessary precursor to diagnosis of antisocial personality behavior in adulthood and typically indicates psychopathic traits, than they are for a variety of other psychiatric disorders, including anxiety,

substance-use, or affective disorders (Kendler et al., 2003). Taken as a whole, these findings on the relationship between genetic factors and psychopathic traits or related disorders may indicate that genetic heritability causes certain individuals to be particularly susceptible to environmental influences encouraging the development of psychopathic traits, while remaining relatively unaffected by attempts at social intervention. However, because parent psychopathic traits were not assessed as part of this study, it is impossible to say whether such a relationship may have existed here, and what affect that may have had on the results of the study, particularly in regard to the relationship between parenting and psychopathic traits.

Limitations

One limitation of the current study is its cross-sectional nature. Although data were taken from a larger, on-going longitudinal study, questionnaires used in this analysis were only implemented during the most recent wave. This means that it is not possible to look at parent-child relationship in earlier stages of development, when the influence of this relationship may have been greater, or to look at the change in parent-child relationship as a moderating factor throughout development. Future studies should look at the moderating effect of parent-child relationship quality on the correlation between biological risk factors to psychopathic traits from a more longitudinal perspective, to gain a more comprehensive understanding of its stability throughout development.

The current study did use self-report data as a measurement of parent-child relationship quality, which is a limitation. However, the questionnaires used in the current study had been shown in other research to have high internal validity (Buhrmester & Furman, 2008; Gordon, 2011), and Cronbach's alpha scores in the current study were at or above acceptable levels for both parent-report and self-report measures of psychopathy and relationship quality. In addition, psychopathy scores measured for the purposes of this study were not entirely self-report; parent and child scores were combined in accordance with the suggestion of the measure's author (Frick, 2004), allowing the study to retain a more reliable total score of CU traits.

Conclusion

This study provides valuable contributions to the current understanding of how social factors may influence the relationship between biological risk factors and psychopathic traits in an adolescent population. The finding that CU traits were significantly correlated with positive parent-child relationship quality, but not with negative relationship quality, further supports a growing body of literature that suggests that intervention strategies targeting CU traits may have a greater impact if focus is placed on the development of positive relationship qualities, rather than on behaviors (such as punishment) that may lead to a more negative perception of the relationship quality, and therefore may reduce the impact of that relationship on development of CU traits. Additionally, the finding that RHR was inversely correlated with psychopathic traits for boys but not for girls is consistent with previous literature suggesting that this correlation can be influenced by child's gender. Future studies examining the interacting effects between interpersonal relationship and biological risk factors from a longitudinal perspective are needed to gain a more comprehensive understanding of the development of psychopathic traits throughout the developmental stages.

Tables

Table 1

Demographics

		Count	Mean
Gender			
	Male	44	
	Female	55	
Age (years)			14.392 (0.779)
Child's race	Caucasian	23	
	Hispanic/Latino	11	
	African American	42	
	Asian/Pacific Islander	2	
	Native American	1	
	Other	2	
	Multiracial	14	
	Decline	4	
Mean RHR			77.783 (11.314)

Note: Standard Deviations are shown in parentheses below means

Table 2

Component Matrix from Principle Component Analysis

	Component	
	1	2
NRIRQV Mother (closeness)	.899	.196
NRIRQV Mother (discord)	-.313	.848
NRIRQV Father (closeness)	.868	.094
NRIRQV Father (discord)	-.054	.907
SSQC Parent (closeness)	.851	.067

Table 3

Pearson Correlations Between Variables

Correlations							
		Gender	CU trait score	PCR (pos.)	PCR (neg.)	RHR	Age
Gender	Pearson Correlation	1					
	Sig. (2-tailed)						
	N	99					
CU trait score	Pearson Correlation	-.088	1				
	Sig. (2-tailed)	.389					
	N	99	100				
PCR (pos.)	Pearson Correlation	-.169	-.396**	1			
	Sig. (2-tailed)	.108	.000				
	N	92	93	94			
PCR (neg.)	Pearson Correlation	.081	.060	.000	1		
	Sig. (2-tailed)	.443	.566	1.000			
	N	92	93	94	94		
RHR	Pearson Correlation	.157	-.089	-.214*	-.087	1	
	Sig. (2-tailed)	.121	.380	.038	.404		
	N	99	100	94	94	101	
Age	Pearson Correlation	-.116	.087	.007	-.039	-.099	1
	Sig. (2-tailed)	.251	.391	.947	.709	.329	
	N	99	100	93	93	100	100

Note: PCR (pos.)= Positive parent-child relationship quality, PCR (neg)= Negative parent-child relationship quality. **= Correlation is significant at the 0.01 level (2-tailed), *= Correlation is significant at the 0.05 level (2-tailed)

Table 4

Hierarchical Regression Analysis between Positive Parent-Child Relationship Quality, Resting Heart Rate, and CU Traits

	CU Traits				
	b	SE	t	p	ΔR^2
Step 1					*.009*
Age	.544	1.202	.453	.652	
Gender	-1.227	1.822	-.674	.502	
Step 2					*.200**
Age	.168	1.096	.153	.879	
Gender	-2.199	1.675	-1.313	.193	
RHR	-.140	.074	-1.896	.061	
PCR (pos.)	-4.070	.890	-4.571	.000	
Step 3					.002
Age	.156	1.101	.142	.888	
Gender	-2.180	1.684	-1.295	.199	
RHR	-.147	.076	-1.932	.057	
PCR (pos.)	-4.068	.895	-4.547	.000	
RHR X PCR (pos.)	-.030	.073	-.415	.679	

Note: PCR (pos.)= Positive parent-child relationship quality, RHR= Resting Heart Rate, *$p \leq .05$

Table 5

Hierarchical Regression Analysis between Negative Parent-Child Relationship Quality, Resting Heart Rate, and CU Traits

	CU Traits				
	b	SE	t	p	ΔR^2
Step 1					*.009*
Age	.544	1.202	.453	.652	
Gender	-1.227	1.822	-.674	.502	
Step 2					*.013*
Age	.416	1.218	.342	.733	
Gender	-1.109	1.847	-.600	.550	
RHR	-.075	.081	-.933	.353	
PCR (neg.)	.460	.927	.496	.621	
Step 3					.019
Age	.319	1.215	.028	.794	
Gender	-.968	1.843	-.525	.601	
RHR	-.089	.081	-1.092	.278	
PCR (neg.)	.572	.927	.617	.539	
RHR X PCR (neg.)	-.085	.065	-1.312	.193	

Note: PCR (neg.) = Negative parent-child relationship quality, RHR= Resting Heart Rate, *$p \leq .05$

Table 6

Hierarchical Regression Analysis between Positive Parent-Child Relationship Quality, Resting Heart Rate, and CU Traits in Boys

	CU Traits				
	b	SE	t	p	ΔR^2
Step 1					*.008*
Age	-1.173	2.083	-.563	.577	
Step 2					*.226**
Age	-1.790	1.913	-.936	.356	
RHR	-.278	.117	-2.380	.023	
PCR (pos.)	-4.167	1.601	-2.602	.013	
Step 3					.016
Age	-2.044	1.942	-1.052	.300	
RHR	-.308	.122	-2.518	.017	
PCR (pos.)	-4.283	1.612	-2.656	.012	
RHR X PCR (pos.)	-.096	.111	-.864	.394	

Note: PCR (pos)= Positive parent-child relationship quality, RHR= Resting Heart Rate , *$p \leq .05$

Table 7

Hierarchical Regression Analysis between Positive Parent-Child Relationship Quality, Heart Rate, and CU Traits in Girls

	CU Traits				
	b	SE	t	p	ΔR^2
Step 1					.022
Age	1.544	1.447	1.067	.291	
Step 2					.255*
Age	1.892	1.313	1.442	.156	
RHR	-.001	.093	-.007	.995	
PCR (pos.)	-4.167	1.027	-4.057	.000	
Step 3					.000
Age	1.907	1.331	1.433	.158	
RHR	-.002	.095	-.025	.980	
PCR (pos.)	-4.160	1.039	-4.033	.000	
RHR X PCR (po.)	-.013	.096	-.136	.892	

Note: PCR (pos)= Positive parent-child relationship quality, RHR= Resting Heart Rate, *$p \leq .05$

Table 8

Mean Resting Heart Rate for Boys and Girls

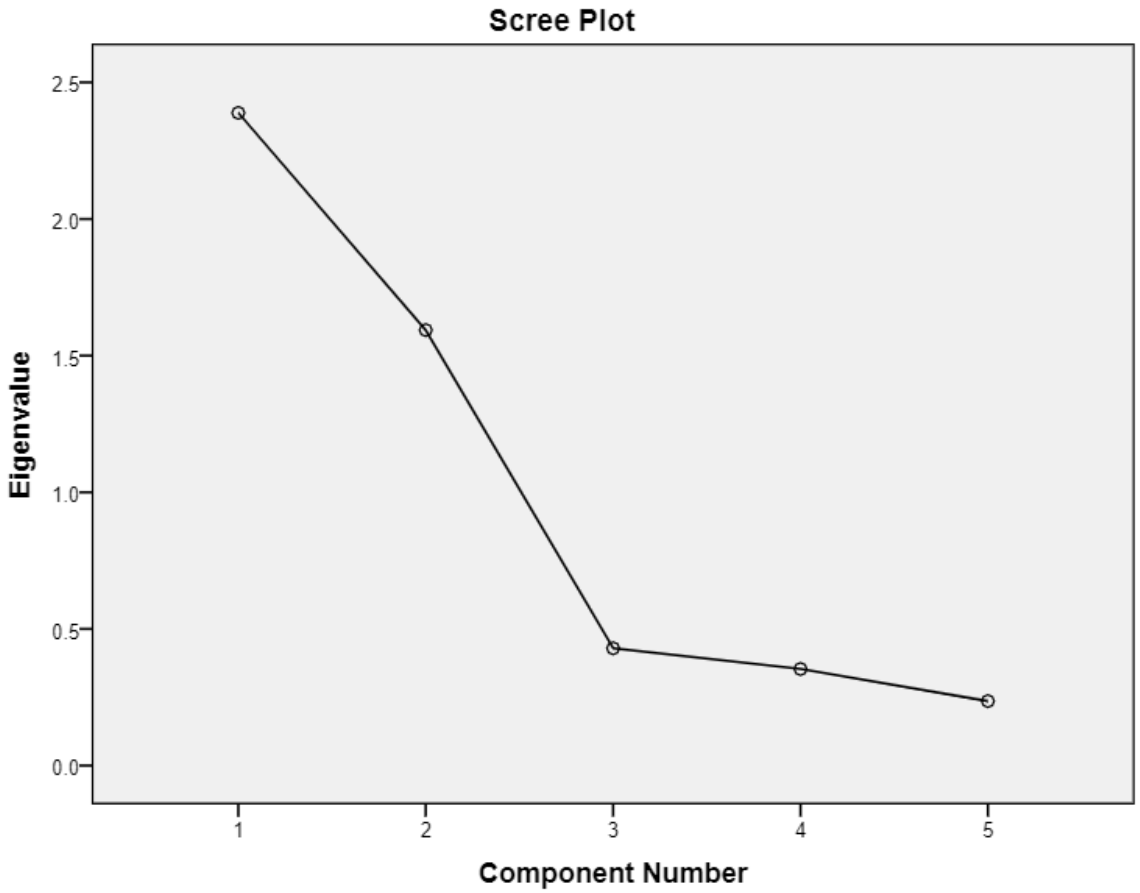
	Gender			
	Males	Females	*t*	*df*
RHR	75.73	79.28	-1.565	97
	(11.18)	(11.25)		

Note: Standard Deviations are shown in parentheses.

Figures

Figure 1

Scree Plot of Results of Principal Component Analysis



References

Acock, A. (2005). Working With Missing Values. *Journal of Marriage and Family*, *67*(4), 1012–1028. doi: https://doi.org/10.1111/j.1741-3737.2005.00191

Aiken, L. S., & West, S. G. (1991). Multiple regression: Testing and interpreting interactions. Thousand Oaks, CA: Sage ISBN: 0-8039-3605-2 (Hardcover)

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders: DSM-5* (5th ed.). Arlington, VA: American Psychiatric Association. ISBN: 0890425558

Barker, E., Oliver, B., Viding, E., Salekin, R., & Maughan, B. (2011). The impact of prenatal maternal risk, fearless temperament and early parenting on adolescent callous-unemotional traits: A 14-year longitudinal investigation. *Journal of Child Psychology and Psychiatry, and Allied Disciplines, 52*(8), 878-888. doi: 10.1111/j.1469-7610.2011.02397.x

Barry, T. D., Barry, C. T., Deming, A. M., & Lochman, J. E. (2008). Stability of Psychopathic Characteristics in Childhood: The Influence of Social Relationships. *Criminal Justice and Behavior, 35*(2), 244-262. 10.1177/0093854807310508

Bergstrøm, H., & Farrington, D. (2018). "The beat of my heart": The relationship between resting heart rate and psychopathy in a prospective longitudinal study. *Journal of Criminal Psychology, 8*(4), 333-344. doi: 10.1108/JCP-07-2018-0029

Blair, R. J. R. (1995). A cognitive developmental approach to morality: Investigating the psychopath. *Cognition, 57*, 1–29. doi: 10.1016/0010-0277(95)00676-P

Buck, K. (2015). Understanding adolescent psychopathic traits from early risk and protective factors: Relations among inhibitory control, maternal sensitivity, and attachment representation. *Journal of Adolescence, 44*, 97-105. doi: 10.1016/j.adolescence.2015.07.009

Buhrmester, D. & Furman, W. (2008). The Network of Relationships Inventory: Relationship Qualities Version. Unpublished measure, University of Texas at Dallas.

Cabrera, F., Herrera, A., Rubalcava, S., & Martínez, K. (2017). Behavior Patterns of Antisocial Teenagers Interacting with Parents and Peers: A Longitudinal Study. *Frontiers in Psychology*, *8*, 757. doi:10.3389/fpsyg.2017.00757

Choy, O., Raine, A., Portnoy, J., Rudo-Hutt, A., Gao, Y., & Soyfer, L. (2015). The Mediating Role of Heart Rate on the Social Adversity-Antisocial Behavior Relationship: A Social Neurocriminology Perspective. *Journal of Research in Crime and Delinquency*, 52(3), 303-341. doi: 10.1177/0022427814565905

Clark, J., & Frick, P. (2018). Positive Parenting and Callous-Unemotional Traits: Their Association With School Behavior Problems in Young Children. *Journal of Clinical Child and Adolescent Psychology, 47*(Sup1), S242-S254. doi: 10.1080/15374416.2016.1253016

Collins, W., Maccoby, E., Steinberg, L., Hetherington, E., & Bornstein, M. (2000). Contemporary research on parenting. The case for nature and nurture. *The American Psychologist*, 55(2), 218-232. doi: 10.1037/0003-066X.55.2.218

Collins, W. A., & Laursen, B. (2004). Changing Relationships, Changing Youth: Interpersonal Contexts of Adolescent Development. *Journal of Early Adolescence*, *24*(1), 55–62. doi: 10.1177/0272431603260882

Crozier, J., Dodge, K., Fontaine, R., Lansford, J., Bates, J., Pettit, G., & Levenson, R. (2008). Social Information Processing and Cardiac Predictors of Adolescent Antisocial Behavior. *Journal of Abnormal Psychology,117*(02), 253-267. doi: 10.1037/0021-843X.117.2.253

Ciucci, E., Baroncelli, A., Franchi, M., Golmaryami, F.N., & Frick, P.J. (2014). The association between callous-unemotional traits and behavioral and academic adjustment in children: Further

validation of the Inventory of Callous-Unemotional Traits. *Journal of Psychopathology and Behavioral Assessment*, 36, 189-200. doi: 10.1007/s10862-013-9384-z

Dadds, M. R., Jambrak, J., Pasalich, D., Hawes, D. J., & Brennan, J. (2011). Impaired Attention to the Eyes of Attachment Figures and the Developmental Origins of Psychopathy. *Journal of Child Psychology and Psychiatry, 52*(3), 238-245. doi: 10.1111/j.1469-7610.2010.02323.x

Dadds, M., Allen, J., Oliver, B., Faulkner, N., Legge, K., Moul, C., . . . Scott, S. (2012). Love, eye contact and the developmental origins of empathy v. psychopathy. *British Journal of Psychiatry*, *200*(3), 191-196. doi:10.1192/bjp.bp.110.085720

Eisenberg, N. (2006). Introduction. In W. Damon & R. M. Lerner (Series Eds.) & N. Eisenberg (Vol. Ed.), Handbook of child psychology: Vol. 3. Social, emotional, and personality development (6th ed., (pp. 1–23). New York: Wiley. ISBN: 9780471272908

Fagan, S. E., Zhang, W., & Gao, Y. (2017). Social Adversity and Antisocial Behavior: Mediating Effects of Autonomic Nervous System Activity. *Journal of Abnormal Child Psychology*, 45(8), 1553-1564. doi:10.1111/psyp.12473

Fisher, L., & Blair, R. J. R. (1998). Cognitive impairment and its relationship to psychopathic tendencies in children with emotional and behavioral difficulties. *Journal of Abnormal Child Psychology*, *26*, 511–519. doi:10.1023/a:1022655919743

Fowles, D. C. (1988). Psychophysiology and psychopathology: A motivational approach. *Psychophysiology*, 25, 373–391. Doi: 10.1111/j.1469-8986.1988.tb01873.x

Frick, P., Cornell, A., Bodin, S., Dane, H., Barry, C., & Loney, B. (2003). Callous-Unemotional Traits and Developmental Pathways to Severe Conduct Problems. *Developmental Psychology, 39*(2), 246-260. Doi: 10.1037/0012-1649.39.2.246

Frick, P.J. & Dickens, C. (2006). Current perspectives on conduct disorder. *Current Psychiatry Reports, 8,* 59-72. doi: 10.1007/s11920-006-0082-3

Frick, P. J., & White, S. F. (2008). Research Review: The importance of callous-unemotional traits for developmental models of aggressive and antisocial behavior. *Journal of Child Psychology & Psychiatry, 49*(4), 359–375. https://doi-org.ezproxy.gc.cuny.edu/10.1111/j.1469-7610.2007.01862.x

Frick, P. J., (2004). *The inventory of callous-unemotional traits*. Unpublished rating scale.

Frick, P. J., Kimonis, E. R., Dandreaux, D. M., & Farell, J. M. (2003). The 4-year stability of psychopathic traits in non-referred youth. *Behavioral Sciences and the Law*, *21*, 713-736. doi: 10.1002/bsl.568

Frick, P. J., & Morris, A. S. (2004). Temperament and developmental pathways to conduct problems. *Journal of Clinical Child and Adolescent Psychology*, 33, 55–68. doi: 10.1207/S15374424JCCP3301_6

Furman, W., & Buhrmester, D. (1985). Children's Perceptions of the Personal Relationships in Their Social Networks. *Developmental Psychology, 21*(6), 1016-1024. doi: 10.1037/0012-1649.21.6.1016

Furman, W., & Buhrmester, D. (1992). Age and sex differences in perceptions of networks of personal relationships. *Child Development, 63*(1), 103-115. doi: 10.2307/1130905

Gordon, A. T. (2011). Assessing social support in children: development and initial validation of the social support questionnaire for children. *LSU Doctoral Dissertations*. 3529. https://digitalcommons.lsu.edu/gradschool_dissertations/3529

Gullone, E. (2012). *Animal Cruelty, Antisocial Behaviour, and Aggression* (The Palgrave Macmillan Animal Ethics Series). London: Palgrave Macmillan UK. Doi: 10.1057/9781137284549

Graaff, J. V., Meeus, W., Wied, M. D., Boxtel, A. V., Lier, P. V., & Branje, S. (2015). Respiratory Sinus Arrhythmia Moderates the Relation between Parent-Adolescent Relationship Quality and Adolescents' Social Adjustment. *Journal of Abnormal Child Psychology,44*(2), 269-281. doi:10.1007/s10802-015-9989-7

Hoffman, M. L. (1983). Affective and cognitive processes in moral internalization. In E. T.Higgins, D.Ruble, & W. W.Hartup (Eds.), *Social cognition and social development* (pp. 236–274). New York: Cambridge University Press. ISBN: 0521245877

Jennings, W. G., Piquero, A. R., & Farrington, D. P. (2013). Does resting heart rate at age 18 distinguish general and violent offending up to age 50? Findings from the Cambridge Study in Delinquent Development. *Journal of Criminal Justice,41*(4), 213-219. doi:10.1016/j.jcrimjus.2013.05.003

Karriker-Jaffe, K. J., Foshee, V. A., Ennett, S. T., & Suchindran, C. (2013). Associations of Neighborhood and Family Factors with Trajectories of Physical and Social Aggression During Adolescence. *Journal of Youth and Adolescence,42*(6), 861-877. doi:10.1007/s10964-012-9832-1

Kavish, N., Boisvert, D., Wells, J., Lewis, R., Cooke, E., Woeckener, M., & Armstrong, T. (2019). On the associations between indicators of resting arousal levels, physiological reactivity, sensation seeking, and psychopathic traits. *Personality and Individual Differences, 141*, 218-225. https://doi.org/10.1016/j.paid.2019.01.013.

Kavish, N., Fu, Q., Vaughn, M., Qian, Z., & Boutwell, B. (2019). Resting Heart Rate and Psychopathy Revisited: Findings From the Add Health Survey. *International Journal of Offender Therapy and Comparative Criminology, 63*(4), 543-557. doi: 10.1177/0306624X18806748

Kavish, N., Vaughn, M., Cho, E., Barth, A., Boutwell, B., Vaughn, S., . . . Martinez, L. (2017). Physiological Arousal and Juvenile Psychopathy: Is Low Resting Heart Rate Associated with Affective Dimensions? *Psychiatric Quarterly, 88*(1), 103-114. doi: 10.1007/s11126-016-9437-z

Kimonis, E., Cross, B., Howard, A., & Donoghue, K. (2013). Maternal Care, Maltreatment and Callous-Unemotional Traits among Urban Male Juvenile Offenders. *Journal of Youth and Adolescence, 42*(2), 165-177. 10.1007/s10964-012-9820-5

Kochanska, G. (1993). Toward a synthesis of parental socialization and child temperament in early development of conscience. *Child Development*, 64, 325–347. doi: 10.2307/1131254

Kochanska, G., Aksan, N., & Joy, M. E. (2007). Children's Fearfulness as a Moderator of Parenting in Early Socialization: Two Longitudinal Studies. *Developmental Psychology, 43*(1), 222–237. https://doi.org/10.1037/0012-1649.43.1.222

Lepper, M. R. (1981). Intrinsic and extrinsic motivation in children: Detrimental effects of superfluous social controls. In W. A.Collins (Ed.), *Minnesota Symposia on Child Psychology: Vol. 14. Aspects of the development of competence* (pp. 155–213). Hillsdale, NJ: Erlbaum. ISSN: 0076-9266

Lopez-Romero, L., Romero, E., & Villar, P. (2012). Relationships between parenting styles and psychopathic traits in childhood. *Behavioral Psychology-Psicologia Conductual, 20*(3), 603-623. **ISSN:** 1132-9483

Lykken, D. T. (1995). *The antisocial personalities*. Hillsdale, NJ: Erlbaum. ISBN: 080581941X

Lynam, D. (1996). Early Identification of Chronic Offenders: Who Is the Fledgling Psychopath? *Psychological Bulletin, 120*(2), 209-234. Doi: 10.1037/0033-2909.120.2.209

Lynam, D. R., Caspi, A., Moffitt, T. E., Loeber, R., & Stouthamer-Loeber, M. (2007). Longitudinal evidence that psychopathy scores in early adolescence predict adult psychopathy. *Journal of Abnormal Psychology*, 116, 155-165. doi: 10.1037/0021-843X.116.1.155

Lynam, D. R., Loeber, R., & Stouthamer-Loeber, M. (2008). The Stability of Psychopathy From Adolescence Into Adulthood: The Search for Moderators. *Criminal Justice and Behavior*, *35*(2), 228–243. https://doi.org/10.1177/0093854807310153

Maccoby, E. E. (1983). Let's not overattribute to the attribution process: Comments on social cognition and behavior. In E. T. Higgins, D. N. Ruble, & W. W. Hartup (Eds.), *Social cognition and social development* (pp. 356–370). New York: Cambridge University Press. ISBN: 0521245877

Miles, D. R., & Carey, G. (1997). Genetic and environmental architecture of human aggression. *Journal of Personality and Social Psychology*, *72*, 207–217. doi: 10.1037/0022-3514.72.1.207

Moffitt, T. E. (2005). The New Look of Behavioral Genetics in Developmental Psychopathology: Gene-Environment Interplay in Antisocial Behaviors. *Psychological Bulletin*, *131*(4), 533–554. doi: 10.1037/0033-2909.131.4.533

O'Brien, B. S., & Frick, P. J. (1996). Reward dominance: Associations with anxiety, conduct problems, and psychopathy in children. *Journal of Abnormal Child Psychology, 24*, 223–240. doi:10.1007/bf01441486

O'Connor, T., Humayun, S., Briskman, J., & Scott, S. (2016). Sensitivity to Parenting in Adolescents With Callous/Unemotional Traits: Observational and Experimental Findings. *Journal of Abnormal Psychology, 125*(4), 502-513. doi: 10.1037/abn0000155

Ortiz, J., & Raine, A. (2004). Heart rate level and antisocial behavior in children and adolescents: A meta-analysis. *Journal of the American Academy of Child and Adolescent Psychiatry, 43,* 154–162. doi: 10.1097/01.chi.0000101373.03068.5c

Padilla-Walker, L. M., & Nelson, L.J. (2010). Parenting and adolescents' values and behavior: the moderating role of temperament. *Journal of Moral Education*, *39*, 491-509. doi: 10.1080/03057240.2010.521385

Pardini, D. A., & Loeber, R. (2008). Interpersonal Callousness Trajectories Across Adolescence: Early Social Influences and Adult Outcomes. *Criminal Justice and Behavior*, *35*(2), 173–196. doi: 10.1177/0093854807310157

Portnoy, J., & Farrington, D. P. (2015). Resting heart rate and antisocial behavior: An updated systematic review and meta-analysis. *Aggression and Violent Behavior, 22*, 33-45. doi:10.1016/j.avb.2015.02.004

Portnoy, J., Chen, F. R., & Raine, A. (2013). Biological protective factors for antisocial and criminal behavior. *Journal of Criminal Justice,41*(5), 292-299. doi: 10.1016/j.jcrimjus.2013.06.018

Portnoy, J., Raine, A., Chen, F. R., Pardini, D., Loeber, R., & Jennings, J. R. (2014). Heart Rate and Antisocial Behavior: The Mediating Role Of Impulsive Sensation Seeking. *Criminology,52*(2), 292-311. doi:10.1111/1745-9125.12038

Raine, A. (1993). *The psychopathology of crime: Criminal behavior as a clinical disorder.* San Diego: Academic Press. ISBN: 9780080572512

Raine, A. (2002). Biosocial Studies of Antisocial and Violent Behavior in Children and Adults: A Review. *Journal of Abnormal Child Psychology,30*(4), 311-326. doi: 10.1023/A:1015754122318

Raine, A., Fung, A. L., Portnoy, J., Choy, O., & Spring, V. L. (2014). Low heart rate as a risk factor for child and adolescent proactive aggressive and impulsive psychopathic behavior. *Aggressive Behavior, 40*(4), 290-299. doi:10.1002/ab.21523

Rhee, S. H., & Waldman, I. D. (2002). Genetic and environmental influences on antisocial behavior: A meta-analysis of twin and adoption studies. *Psychological Bulletin, 128,* 490–529. doi: 10.1037/0033-2909.128.3.490

Robinson, B., Azores-Gococo, N., Brennan, P., & Lilienfeld, S. (2016). The Roles of Maternal Psychopathic Traits, Maternal Antisocial Personality Traits, and Parenting in the Development of Child Psychopathic Traits. *Parenting, 16*(1), 36-55. doi: 10.1080/15295192.2016.1116894

Rothbart, M. K., & Bates, J. E. (2006). Temperament. In W.Damon & R. M.Lerner (Series Eds.) & N.Eisenberg (Vol. Ed.), *Handbook of child psychology: Vol. 3. Social, emotional, and personality development* (6) 99–166. New York: Wiley. ISBN: 9780471272908

Sadeh, N., Javdani, S., Jackson, J.J., Reynolds, E.K., Potenza, M. N., & Gelernter, J. (2010). Serotonin transporter gene associations with psychopathic traits in youth vary as a function of socioeconomic resources. *Journal of Abnormal Psychology*, *119*, pp. 604-609, doi: 10.1037/a0019709

Silva, T., & Stattin, H. (2016). The moderating role of parenting on the relationship between psychopathy and antisocial behavior in adolescence. *Development and Psychopathology, 28*(2), 505-515. doi: 10.1017/S0954579415001121

Sijtsema, J. J., Veenstra, R., Lindenberg, S., van Roon, A. M., Verhulst, F. C., Ormel, J., et al.(2010). Mediation of sensation seeking and behavioral inhibition on the relationship between heart rate and antisocial behavior: The TRAILS study. *Journal of the American Academy of Child and Adolescent Psychiatry*, *49*, 493–613. doi: 10.1016/j.jaac.2010.02.005.

Soderstrom, H., Nilsson, T., Sjodin, A., Carlstedt, A., & Forsman, A. (2005). The childhood-onset neuropsychiatric background to adulthood psychopathic traits and personality disorders, *Comprehensive Psychiatry, 46* (2), 111-116. doi: 10.1016/j.comppsych.2004.07.030.

Soderstrom, H., Nilsson, T., Sjodin, A., Carlstedt, A., & Forsman, A. (2014). Adult psychopathic personality with childhood-onset hyperactivity and conduct disorder: a central problem constellation in forensic psychiatry. *Psychiatry Research, 121* (3), 271-280. doi: 10.1016/S0165-1781(03)00270.

Tarvainen, M. P., Niskanen, J.-P., Lipponen, J. A., Ranta-aho, P. O. & Karjalainen, P. A. (2014). Kubios HRV–heart rate variability analysis software. *Computer Methods and Programs in Biomedicine*, 113, 210–220. doi: 10.1016/j.cmpb.2013.07.024

Task Force Of The European Society Electrophysiology. (1996). Heart Rate Variability. *Circulation, 93*(5), 1043-1065. doi:10.1161/01.cir.93.5.1043

Tsopelas, C., & Armeniaka, M. (2012). From conduct disorder in childhood to psychopathy in adult life. *Psychiatriki*, 23(1), 107-116. ISSN: 1105-2333

Viding, E., Blair, J.B. , Moffitt, T.E. , & Plomin, R. (2005). Evidence for substantial genetic risk for psychopathy in 7-year olds. *Journal of Child Psychology and Psychiatry, 46*, 592-597. doi: 10.1111/j.1469-7610.2004.00393.x

Waller, R., Trentacosta, C. J., Shaw, D. S., Neiderhiser, J. M., Ganiban, J. M., Reiss, D., … Hyde, L. W. (2016). Heritable temperament pathways to early callous-unemotional behaviour. *The British Journal of Psychiatry, 209*(6), 475–482. doi:10.1192/bjp.bp.116.181503

Waller, R., Shaw, D., & Hyde, L. (2017). Observed fearlessness and positive parenting interact to predict childhood callous‐unemotional behaviors among low‐income boys. *Journal of Child Psychology and Psychiatry, 58*(3), 282-291. doi: 10.1111/jcpp.12666

West, S., Aiken, L., Cham, H., & Liu, Y. (2013). Multiple Regression. *The Oxford Handbook of Research Strategies for Clinical Psychology,* The Oxford Handbook of Research Strategies for Clinical Psychology. doi: 10.1093/oxfordhb/9780199793549.013.0013