HOWARD UNIVERSITY

Adverse Childhood Experiences, Racial Identity, and Cardiac Autonomic Dysregulation

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Christian A. Mallett

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GRADUATE SCHOOL
DEPARTMENT OF PSYCHOLOGY

THESIS COMMITTEE

Denee T. Mwendwa, Ph.D.
Chairperson

Alfonso L. Campbell, Jr., Ph.D.

Camara Jules P. Harrell, Ph.D.

Camara Jules P. Harrell, Ph.D.
Thesis Advisor

Candidate: Christian A. Mallett

Date of Defense: July 27, 2018

DEDICATION

I dedicate this thesis to my beloved mother, Danita Donatto-Mallett.

Thank you for your immense hard work, sacrifice, and love to give me an amazing life.

"Mama Hold My Hand" - Egbert Nathaniel Dawkins III

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ABSTRACT

Background: Previous studies have related adverse childhood experiences (ACE) to heart disease. However, more research needs to explore neural mechanisms and psychological factors that contribute to the pathway of adverse childhood experiences leading to heart disease. **Purpose:** The present study examines racial identity as a moderator of adverse childhood experiences and cardiac autonomic dysregulation as indexed by respiratory sinus arrhythmia. **Method:** Forty-six undergraduate students of African descent attending a Historically Black University in the Mid-Atlantic region of the United States participated in this study. During the first phase, participants completed consent forms and questionnaires including the ACE Scale and the Cross Racial Identity Scale. Participants returned to the laboratory on a second occasion during which researchers employed an impedance cardiograph to record resting levels of interbeat intervals (IBI) and respiratory sinus arrhythmia (RSA). **Results:** Ordinary least squares **r**egression analyses were conducted to test the moderating role of racial identity attitudes on the relationship between ACE prevalence and RSA. The overall regression model which included ACE prevalence, Multiculturalist attitudes, gender, and all interaction terms significantly predicted resting IBI. The overall model that included ACE prevalence, Afrocentric attitudes, gender, and all interaction terms also significantly predicted resting IBI. Participants with ACE and Afrocentric attitudes were more likely to have decreased resting RSA. Furthermore, in addition to ACE prevalence and Afrocentric attitudes, considering gender added 10% more explanatory variance in predicting resting RSA. Male participants with ACE and low Afrocentricity ratings were more likely to have decreased resting RSA. Additionally, considering gender with ACE prevalence and Miseducation attitudes added 10% more explanatory variance in predicting resting RSA. **Discussion:** Results and limitations are further discussed in the context of existing literature.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1: INTRODUCTION

Theoretical and Conceptual Frameworks

Five theoretical systems converge to inform the present study. They are the Ecological Theory of Human Development, the Adverse Childhood Experiences Pyramid, the Cognitive Model, Nigrescence Theory, and Polyvagal Theory. Bronfenbrenner's Ecological Theory of Human Development frames society as being comprised of interrelated systems such as the family, neighborhood and education system, societal values, and notable instances during the passage of time. Devised after a public health study conducted by the Centers for Disease Control and Kaiser Permanente in the 1990s, the Adverse Childhood Experiences (ACE) Pyramid is a conceptual model that outlines the trajectory of many adverse childhood experiences leading to disease, disability, and early death. The ACE Pyramid conceptualizes that adverse childhood experiences lead to disrupted neurodevelopment, leading to social, emotional, and cognitive impairment, leading to adoption of health risk behaviors, leading to disease, disability, and social problems, and ultimately, leading to early death. Beck's Cognitive Model suggests that adverse childhood experiences lead the amygdala to become hyper-reactive to subsequent negative stimuli, resulting in negative cognitive bias. This negative cognitive bias may lead individuals to adopt negative attitudes about themselves and others as members of a particular racial group. In Cross' Nigrescence Theory, he describes categorizations of negative and positive attitudes about one's Black racial identity. Porges developed a Polyvagal Theory, in which he specifies animals' varying capacities for responding to stressful events, identifies neural circuits from the brain stem to the heart, and identifies heart rate variability as an index of responding to stress or challenge. Each theoretical paradigm will be discussed in detail presently.

Ecological Theory of Human Development

Bronfenbrenner's Ecological Theory of Human Development conceptualized individuals as the product of "nested," "interrelated" systems that compose society (Durkin, 1995). From the most proximal to the distal, these systems include the microsystem, mesosystem, exosystem, macrosystem, and chronosystem (Durkin, 1995). As described in Bronfenbrenner's seminal *American Psychologist* article, the microsystem is the "complex of relations between the developing person and environment in an immediate setting containing that person (e.g., home, school, workplace, etc.)" (Bronfenbrenner, 1977). The microsystem includes the parents and siblings, teachers and classmates, coaches and teammates.

Bronfenbrenner explained that the "mesosystem comprises the interrelations among major settings containing the developing person at a particular point in his or her life" (Bronfenbrenner, 1977). In other words, the mesosystem is the layer of environment where various microsystems interact, for example: parents attending a parent teacher conference at school or friends from school coming to the house for a slumber party. Bronfenbrenner (1997) defined the exosystem as "an extension of the mesosystem embracing other specific social structures, both formal and informal, that do not themselves contain the developing person, but impinge upon or encompass the immediate settings in which that person is found, and thereby influence, delimit, or even determine what goes on there." Examples of exosystems include the justice system, the education system, "the neighborhood," "mass media," state and local government, etc. (Bronfenbrenner, 1997). Bronfenbrenner (1997) contrasts the macrosystem with the other systems in that "it refers not to the specific contexts affecting the life of a particular person but to general prototypes, existing in the culture or subculture, that set the pattern for the structures and activities occurring at the concrete level." The macrosystem includes the overall values and ideologies of the society and culture. The chronosystem is the result of consistency or significant changes in time in the developing person's life (Bronfenbrenner, 2006).

Adverse Childhood Experiences Pyramid

Between 1995 and 1997, the Centers for Disease Control and Prevention (CDC) and Kaiser Permanente's Health Appraisal Center (HAC) conducted a study examining the relationship of adverse childhood experiences (ACE) to health risk behaviors and chronic diseases. The original ACE Study (Felitti et al., 1998), which included over 8,000 patients, found that those with higher ratings of adverse childhood experiences were more likely to experience alcoholism, depression, ischemic heart disease, cancer, and other chronic diseases. After reviewing the ACE Study findings, the CDC and Kaiser Permanente devised the ACE Pyramid, which depicts the conceptual framework outlining the pathways adverse childhood experiences lead to early death. Through the ACE Pyramid, illustrated in Figure 1, the CDC and Kaiser Permanente purport that adverse childhood experiences lead to disrupted neurodevelopment followed by social, emotional, and cognitive impairment; adoption of health risk behaviors; disease, disability, and social problems; and ultimately, early death.

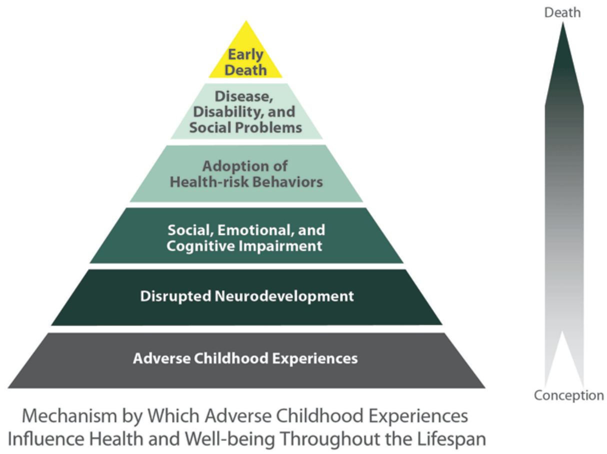

Figure 1. The ACE Pyramid outlining the paths along which the CDC and Kaiser Permanente conceptualize adverse childhood experiences leading to early death. Figure retrieved from the CDC website on January 17, 2017.

Cognitive Model of Depression

Dong et al. (2004) found a significant mediating role of psychological factors (i.e., depressed affect and anger) in the relationship between ACE exposure and ischemic heart disease (IHD) risk. This finding highlights the importance of examining psychological factors that may underlie or facilitate the development of IHD after experiencing a range of adverse childhood experiences. A predominant orientation of conceptualizing psychological disorders is the Cognitive Model.

Developed by Aaron Beck, the cognitive model purports that thoughts affect emotions, physiological responses, and behaviors. Beck (2008) explicated the neurobiological basis of his cognitive model of depression. Beck (2008) suggested that adverse childhood experiences lead the amygdala to become hyper-reactive to subsequent negative stimuli, resulting in negative cognitive bias in the individual. This formulation is consistent with the conceptualization outlined in the ACE Pyramid that adverse childhood experiences lead to disrupted neurodevelopment and then social, emotional, and cognitive impairment. Additionally, Beck (2008) explained that when a person experiences stress, the hypothalamic-pituitary-adrenal (HPA) axis releases cortisol, a stress hormone of which depressed individuals have an excess. Though Beck (2008) focused on the role adverse experiences play in the activation of the HPA axis, stress also causes responses in the sympathetic, parasympathetic, and enteric nervous systems (Habib, Gold, & Chrousos, 2001). The present study will focus on adverse experiences' role in dysregulating activity in the cardiac parasympathetic nervous system branch of the autonomic nervous system.

The cognitive model conceptualizes that adverse experiences lead to negative cognitive bias and diminished reality testing (Beck, 2008). The negative cognitive bias results in negative thoughts in reaction to situations. These negative thoughts activate negative emotions, physiological responses, and maladaptive behavior customary of depression. This study will also examine the physiological responses generated from negative thought patterns which are common in those who have had many adverse experiences.

Nigrescence Theory

Race is a term of dubious biological meaning when applied to humans but is a major identifying demographic characteristic in the United States of America. As such, individuals may have positive, negative, and mixed attitudes about themselves and others as members of a particular racial group. These perceptions can be shaped by attitudes filtered down from the macrosystem through to the exosystem and microsystem. In W. E. B. Du Bois' Souls of Black Folk, published in 1903, he explicates the concept of *double consciousness*, the tension between realizing one is both Black and American. Du Bois (1903) writes: "one ever feels his twoness,--

an American, a Negro; two souls, two thoughts, two unreconciled strivings; two warring ideals in one dark body, whose dogged strength alone keeps it from being torn asunder" (p.45). The negative cognitive bias associated with early adverse experiences that Beck (2008) discusses can lead individuals to harbor negative views about themselves and others. One can suppose that one who has many adverse experiences is more likely to adopt negative attitudes about oneself and others as a member of a particular racial group.

William Cross' Nigrescence Theory (Cross 1971, 1991) has emerged as a seminal model of conceptualizing of African-American identity development. Cross devised the Nigrescence Model to chart three stages which African Americans may move through from espousing negative attitudes about being Black to espousing positive attitudes. The three stages of Black identity development which Cross outlines are Pre-Encounter, Immersion-Emersion, and Internalization. Individuals in the Pre-Encounter stage either hold negative attitudes about Black identity or Black identity is not salient to them. In the Immersion-Emersion stage individuals solely consume Black culture and have disdain for White people. Those in the Internalization stage have reached a place of acceptance and pride in their Black identity.

Polyvagal Theory

Porges' Polyvagal Theory includes a paradigm with explanations of how the nervous system has evolved to respond to stressful situations. Porges (1995) conceptualized Polyvagal Theory from an evolutionary, neurophysiological, and neuroanatomical perspective. In Polyvagal Theory, Porges (2001) argues that as reptiles evolved into mammals, the autonomic nervous system developed additional neural circuits. The primary stress response for reptiles was immobilization, which is freezing to camouflage into the environment to hide from predators

(Porges, 2001). This immobilization response included bradycardia and apnea to conserve energy (Porges, 2001). Although this immobilization response is adaptive for reptiles, it can be lethal for mammals because of the energy and oxygen demands required of mammalian bodies (Porges, 2001). The autonomic nervous system of mammals developed the sympathetic nervous branch, which engages a mobilization response to threat commonly known as "fight or flight" (Porges, 2001). Mammals developed what Porges (2001) refers to as the Social Engagement System. When mammals are in a state where no threat is perceived, they are able to positively communicate and interact with other conspecifics (Porges, 2001). Porges (2001) purports that growth is facilitated during this Social Engagement state.

The tenth cranial nerve, the vagus, modulates a range of internal organs including the colon and the heart. According to Porges (1995), the vagus plays a role in the way animals respond to threat. Vagal fibers which terminate on the sinoatrial node, the heart's natural pacemaker, slow the rate of heart beats (Porges, 1995). Porges (1995) describes the two efferent branches of the vagus: the dorsal motor nucleus of the vagus (DMNX) and the nucleus ambiguus (NA). The unmyelinated fibers of the of the DMNX extend to subdiaphragmatic structures like the stomach and intestines and regulate digestion and the distribution of nutrients. Porges (1995) proposes that the DMNX vagus contributes to a "passive reflexive motor system associated with vegetative function." The rostral section of the NA also extends to subdiaphragmatic structures, but most of the myelinated NA fibers extend to the supradiaphragmatic structures like the "larynx, pharynx, soft palate, esophagus, bronchi, and heart" (Porges, 1995). Polyvagal Theory proposes that the NA fibers contribute to an "active voluntary motor system associated with the conscious functions of attention, motion, emotion, and communication" (Porges, 1995).

Porges describes that the external subdivision of NA fibers (NA_{ex}) terminates on the bronchi, which are the main airways into the lungs, and on the sinoatrial node, which is the pacemaker of the heart (Porges, 1995). Porges (1995) states that NA_{ex} vagal fibers have respiratory rhythm. Under Premise 4 of Polyvagal Theory, as the influence of the NA_{ex} increases, the associated respiratory rhythm interacts with the sinoatrial node to create respiratory sinus arrhythmia (RSA). Porges (1995) acknowledges that though other vagal and nonvagal factors contribute to heart rate and respiratory rhythm, NA is the "primary, if not sole, source of respiratory rhythms on the sinoatrial node." Therefore, Porges (1995) considers RSA to be a measure of vagal tone.

During the third phylogenetic stage, the Social Engagement system, a child does not perceive a threat in the environment and can participate in self-soothing and calming (Porges, 2007). However, during an aversive event such as child abuse, either the child's sympathetic system activates to encourage a mobilization response or the unmyelinated vagus activates to freeze the child. After a traumatic event, if the child is frequently triggered to relive the trauma, the child spends less time in the healing and developing Social Engagement System during which smart vagus tone increases. Additionally, when a child is in an environment in which they experience a range of adverse events, the child spends less time having the myelinated vagus activated to experience social communication, self soothing, and calming. Therefore, individuals who have experienced more adverse events in childhood likely have less pronounced RSA. One might speculate that individuals with racial identity attitudes associated with poor social communication such as Cross' Miseducation and Self-Hatred likely spend less time in the stage where the myelinated vagus is activated, and therefore have poorer RSA.

Summary

Layers of social systems are active in the rearing of children. Bronfenbrenner's

Ecological Theory of Human Development details the systems of the microsystem, mesosystem, exosystem, macrosystem, and chronosystem (Durkin, 1995). When children live in microsystems (households) in which they experience many adverse childhood experiences, they are at greater risk for developing heart disease and depressive symptoms (Dong et al., 2004; Beck, 2008). The negative cognitive bias resulting from adverse childhood experiences could lead individuals to adopt negative attitudes about members of their race (miseducation) and of themselves based on their race (self-hatred). Decreased time spent positively interacting with others and self soothing likely leads to poorer rates of RSA, an index of cardiac autonomic dysregulation which has also been associated with depression. These theories are compiled in Figure 2 below.

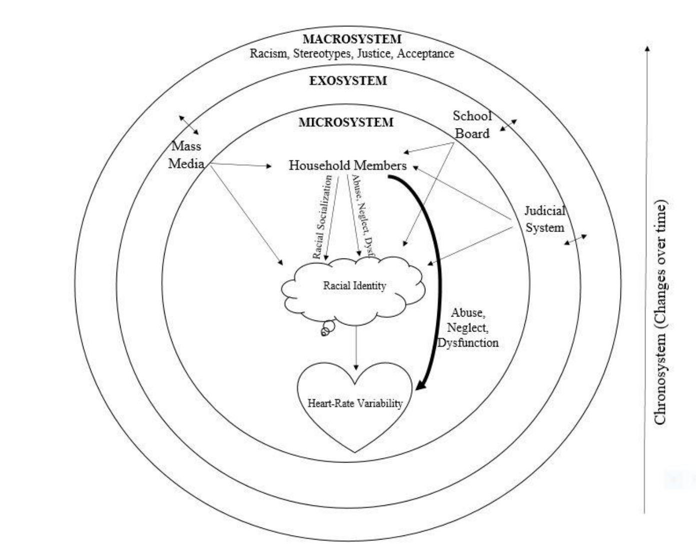

Figure 2. Model integrating Bronfenbrenner's Ecosocial Theory of Human Development, the ACE Pyramid, Beck's Cognitive Model, Cross' Nigrescence Theory, and Porges' Polyvagal Theory.

CHAPTER 2: LITERATURE REVIEW

Empirical Findings Relating Adverse Experiences to Physiological Activity

Bailey et al. (2017) compiled data from the US Census, National Center for Health Statistics, National Center for Education Statistics, US Bureau of Labor Statistics, and the Kaiser Family Foundation to examine the adverse effects of structural racism on health inequities in the United States. Bailey et al. (2017) reported the age-adjusted mortality rate related to heart disease in 2014 per 100,000 people: 206.3 Black non-Hispanic, 165.9 White non-Hispanic, 119.1 Native American or Alaskan Native, 116.0 Hispanic or Latino, 86.1 Asian. Bailey et al. (2017) reported potential life lost before the age of 75 years per 100,000 people (as of 2014): 9,490.6 Black non-Hispanic, 6,954.0 Native American or Alaska Native, 6,659.4 White non-Hispanic, 4676.8 Hispanic or Latino, 2954.4 Asian. Bailey et al. (2017) reported the proportion of adults reporting serious psychological distress in the past 30 days (2013-2014): 5.4% Native American or Alaska Native, 4.5% Black non-Hispanic, 3.5% Asian, 3.4% White non-Hispanic, 1.9% Hispanic or Latino. Bailey et al. (2017) cite the following as pathways linking structural racism to health: economic injustice and social deprivation, environmental and occupational health inequities, psychosocial trauma, targeted marketing of health-harming substances, inadequate health care, state-sanctioned violence and alienation from property and traditional lands, political exclusion, maladaptive coping behaviors, and political exclusion. This data highlights the impact adverse events stemming from the environment and social factors (i.e., structural racism) can have, translating to health disparities.

Adverse events in the exosystem environment have also been correlated with mental health effects. Bor, Venkataramani, Williams, and Tsai (2018) used a population-based, quasi-experimental design of 103,710 Black Americans to examine the mental health effects of exposure to police killings of unarmed Black Americans. Bor et al. (2018) matched police killing occurrences of unarmed Black Americans with self-reported mental health data for participants by state. Bor et al. (2018) garnered the data on police killings from the Mapping Police Violence (MPV) database, using data from (2013-2015). Bor et al. (2018) retrieved demographic and mental health responses from the US Behavioral Risk Factor Surveillance System (BRFSS). Bor et al. (2018) participants were matched to police killings of unarmed Black Americans that occurred 3 months before the date of the BRFSS interview in the same state as each participant. Bor et al. (2018) used the following item from the BRFSS as their mental health variable: “Now thinking about your mental health, which includes stress, depression, and problems with emotions, for how many days during the past 30 days was your mental health not good?” Thus, the number of days participants reported their mental health to be not good was Bor et al. (2018)’s outcome variable. Thirty-eight thousand, nine hundred ninety three individuals were interviewed “0-3 months after at least one police killing of an unarmed black American in the same state” (Bor et al., 2018). Participants were exposed to either one killing of an unarmed Black American on average (range 0-7) in the three months preceding the interview or exposed to four killings per year (Bor et al., 2018). Bor et al., (2018) found that “each additional police killing of an unarmed black American in the respondent’s state of residence in the 3 months prior to interview was associated with a 0.14 day increase in the number of poor mental health days.” Furthermore, Bor et al. (2018) found that “exposure to one or more police killings was associated with a 0.35 day increase in poor mental health days.” Bor et al. (2018) estimate that “police killings of unarmed black Americans could contribute 1·7 additional poor mental health days per person per year or 55 million excess poor mental health days per year among black American adults in the USA.” These finding illustrate the widespread effects that exposure to adverse events could have on mental health.

As outlined in Bronfenbrenner (1977) the microsystem is highly influential on the well-being of the developing child. Research has studied how adverse events in the home have lasting physical and mental health outcomes. Dong et al. (2004), a follow-up to the original ACE Study, focused specifically on the relationship between adverse childhood experience prevalence and self-reported ischemic heart disease (IHD). Logistic regression models found that aside from marital discord, endorsement of any type of the included adverse experiences significantly increased the likelihood of reporting IHD (Dong et al., 2004). Furthermore, Dong et al. (2004) found a graded relationship between ACE prevalence and heart disease in that for every increase in ACE score, participants were 20% more likely to report IHD. ACE prevalence independently predicted likelihood of IHD by 10% after controlling for traditional and psychological risk factors. Participants who endorsed psychological risk factors for IHD (i.e., depressed affect and anger) reported higher prevalence of IHD than participants that endorsed only traditional risk factors (diabetes, hypertension, smoking, obesity, physical inactivity) (Dong et al., 2004); this finding highlights the importance of examining psychological factors that strengthen the relationship between adverse childhood experiences and ischemic heart disease.

Given Dong et al. (2004)'s sample size of 17,337, the results are compelling and encourage further investigation. However, as a public health study, the measures briefly screened rather than deeply assessed for conditions. History of ischemic heart disease was collected by "a positive response to any of the three questions: 'Have you had or ever been told you have a heart attack (coronary)?' 'Do you get pain or heavy pressure in the chest with exertion?' or 'Do you use nitroglycerine?'" (Dong et al., 2004). Though the answers to these questions can tell us if the participant has a history of heart disease, they do not tell us the biological mechanisms affected which led to the heart disease. Studies which assess medical outcomes such as heart rate, blood pressure, body mass index, waist circumference, etc. and neural mechanisms such as heart rate variability would give a closer look at how adverse childhood experiences affect the body. Additionally, psychological risk factors were assessed by yes/no responses to these two questions: "Have you ever had reason to fear your anger getting out of control?" and "Have you had or do you now have depression or feel down in the dumps?" (Dong et al., 2004). Psychologists have in-depth, empirically validated measures of assessing depressive and anger symptoms that are able to describe nuances in clients' symptoms.

In a sample of 13,093 Canadian adolescents and adults, Fuller-Thomson, Brennenstuhl, and Frank (2010) found a significant relationship between childhood physical abuse and heart disease even after controlling for childhood stressors, adult health behaviors, adult stressors, depression, and high blood pressure. However, 86 percent of this sample were White Canadians. In America, African-Americans have the highest rate of heart disease in the country. This highlights the need to examine factors that lead to the high rate of heart disease among African Americans and factors that could facilitate prevention. Additionally, there is a need to examine the mechanisms and moderators that link child abuse to heart disease.

Pretty, O'Leary, Cairney, and Wade (2013) examine physiological measures (medical outcomes) that may underpin the relationship between adverse childhood experiences and heart disease. Pretty, O'Leary, Cairney, and Wade (2013) tested for a relationship between adverse childhood experiences and risk factors for heart disease in a sample of 1,234 children in grades 6 through 8. Pretty et al. (2013) included the following measures: the Childhood Trust Events Survey, heart rate (HR), blood pressure (BP), body mass index (BMI), and waist circumference (WC). Logistic regression analyses that found four or more adverse childhood experiences had a significant effect on HR, BMI, and WC (Pretty et al., 2013). These results suggest that individuals who experience more adverse experiences in childhood are more likely to have risk factors for cardiovascular disease such as elevated resting heart rate, body mass index, and waist circumference. Though Pretty et al. (2013) used physiological measures, studies which measure neural mechanisms would identify specific pathways by which adverse childhood experiences lead to heart disease. Heart rate variability is a neural mechanism considered as a refined measure of predicting cardiac autonomic dysregulation. Studies that include heart rate variability can identify the pathway by which adverse childhood experiences influence cardiac autonomic dysregulation.

Miskovic, Schmidt, Georgiades, Boyle, MacMillan (2009) examined an index of heart rate variability known as respiratory sinus arrhythmia (RSA) in a sample of adolescent females who had experienced child maltreatment (n = 38; M age = 14.47) and their age-matched, non-maltreated (n = 25; M age = 14.00) peers. The participants were classified as having a history of maltreatment by child protection agencies in the south central region of Ontario, Canada (Miskovic et al., 2009). To determine abuse exposure and severity, two members of the research team and two clinical researchers read case summaries and independently determined eligibility (Miskovic et al., 2009). Maltreated females exhibited significantly lower RSA amplitude than their age-matched, non-maltreated counterparts at both the initial recording and at a six month follow-up recording (Miskovic et al., 2009). However, maltreatment was no longer a significant predictor of RSA amplitude at the initial recording after controlling for socioeconomic status (SES) (Miskovic et al., 2009). Also, maltreatment was no longer a significant predictor of RSA amplitude at the six month follow-up after controlling for the time of day RSA was recorded (Miskovic et al., 2009). This study gives evidence that adverse childhood experiences lead to recognizable cardiac dysregulation, as indexed by RSA, at a young age and sustains over time.

Jovanovic et al. (2011) is another study that measures the neural mechanism, heart rate variability, to examine the pathway along which adverse childhood experiences affect cardiac autonomic dysregulation. Namely, Jovanovic et al. (2011) examined the transgenerational effects of trauma on children's cardiac autonomic regulation. Because of the increased risk that low income, African-American men and women in urban environments are exposed to trauma, Jovanovic et al. (2011) assessed low income African American mothers' childhood abuse and their children's LF/HF heart rate variability. The study, which included 36 children, found that after controlling for child demographics and maternal psychopathology, "maternal Emotional Abuse accounted for 20.6% of the variance in HRV" (Jovanovic et al., 2011). This study provides support of the long-lasting effects of child abuse on children's cardiac autonomic regulation, especially in a low income, African-American population.

Zilioli et al. (2016) incorporated a psychological factor, self-esteem, into the examination of the effects of adverse childhood experiences on stress responses. Zilioli et al. (2016) examined the mitigating effects of self-esteem on the relationship between childhood adversity and cortisol levels in a sample of adults (*M* age = 56.62 years, *SD* = 12.05 years). Zilioli et al. (2016) found that self-esteem reduced the effect of childhood adversity for morning cortisol and cortisol slope. This finding suggested that an individual's perception of themselves may moderate the role adverse childhood experiences could play in cardiac autonomic dysregulation.

Neblett and Roberts (2013) examined racial identity as as moderator of the effects of discrimination on autonomic responses. One hundred and five African-American college students listened to audio vignettes depicting both blatantly and subtly racist interactions with White and Black perpetrators. While participants listened to each condition, their heart rate variability (RSA) was collected. Participants with moderate and high levels of positive feelings about their Black identity (i.e., private regard) exhibited decreased vagal tone (RSA) while listening to the blatant racism condition when the perpetrator was Black compared to the increased vagal tone during the recovery period. Additionally, when listening to the blatant racism interaction with the White perpetrator, participants with low levels of positive feelings about their Black identity exhibited decreased vagal tone compared to the increased vagal tone during the recovery period. Neblett and Roberts (2013) provides support that racial identity can enhance or mitigate parasympathetic activity in response to a threat. Of note, the focus of Neblett and Roberts (2013) was on examining parasympathetic reactivity to threat; the study's focus was not on examining dispositional cardiac autonomic changes after experiencing adverse events (as measured by resting heart rate variability). Jones and Neblett (2017) recommends that researchers "assess racism-related stress within the context of youths' 'general' stress burden." The scope of the present master's thesis will seek to examine racial identity as an enhancement or buffer for the effect of adverse childhood experiences on cardiac autonomic regulation.

In summary, large-sample studies have related childhood adversity to heart disease (Dong et al, 2004; Fuller-Thomson et al., 2010). Bailey et al. (2017), another large-sample study, highlighted the disparity in mortality related to heart disease between African Americans and other major ethnic groups. Bor et al. (2018) found that exposure to an adverse event (i.e., killing of an unarmed Black American within one's state of residence) led to an increase in reported poor mental health days among a large sample of African Americans. Some studies related childhood adversity to physiological outcomes (Pretty et al., 2013; Zilioli et al., 2016). Few studies examined and related childhood adversity to heart rate variability (Miskovic et al., 2009; Jovanovic et al., 2011). Some of the studies highlighted the importance of considering psychological factors in the pathway of adverse experiences leading to disrupted physiological systems (Dong et al., 2004; Zilioli et al, 2016; Neblett & Roberts, 2013).

Research Hypotheses

RH1: Prevalence of adverse childhood experiences will be negatively correlated with resting interbeat intervals (IBI).

Rationale: Decreased resting interbeat intervals is associated with poorer heart health. As Dong et al. (2004) found that adverse childhood experience prevalence was significantly related to ischemic heart disease in adults, individuals with more ACE in the present sample may have decreased resting heart rate as a precursor to heart disease.

RH2: Prevalence of adverse childhood experiences will be negatively correlated with resting heart-rate variability as indexed by respiratory sinus arrhythmia.

Rationale: Dong et al. (2004) found that prevalence of adverse childhood experiences was significantly related to likelihood of having ischemic heart disease. Early signs of cardiac autonomic dysregulation may be detectable through HRV among those who have many adverse childhood experiences.

RH3: Negative attitudes about Black identity will enhance the negative impact of adverse childhood experiences on IBI. Conversely, positive attitudes about Black identity will mitigate the negative impact of adverse childhood experiences on IBI.

Rationale: Dong et al. (2004) found that psychological factors (i.e., depressed affect and anger) mediate the relationship between ACE prevalence and IHD. Perhaps another psychological factor, such as racial identity, can influence the relationship between ACE prevalence and IBI.

RH4: Negative attitudes about Black identity will enhance the negative impact of adverse childhood experiences on HRV. Conversely, positive attitudes about Black identity will mitigate the negative impact of adverse childhood experiences on HRV.

Rationale: Dong et al. (2004) found that psychological factors (i.e., depressed affect and anger) mediate the relationship between ACE prevalence and IHD. Perhaps another psychological factor, such as racial identity, can influence the relationship between ACE prevalence and HRV.

CHAPTER 3: METHODOLOGY

Design

The present study utilizes a between-participants, correlational design. Data collected in Dr. Jules P. Harrell's Psychophysiology Lab from 2015-2016 will be used to conduct the analyses for this study.

Participants

Forty-six Howard University undergraduate students participated in this study. Seventy-six percent of the subjects (*n* = 35) identified themselves as female, while 24% (*n* = 11) identified themselves as male. Participants ranged in age from 18-24 years old (*M* = 19.76, *SD* = 1.52). Subjects indicated their ethnic background: 80% African-American, 9% West Indian/Caribbean Black, 6% African, 2% Mixed and 2% other. As an aim of the study was to examine the effects of Black racial identity attitudes on cardiac autonomic dysregulation, participants who rated their ethnic background as "Other" were excluded from the regression analyses. Participants rated their socioeconomic status: 7% poor, 24% working class, 46% middle class, 24% upper middle class. Subjects were compensated for participation by receiving a research credit in a psychology course in which they were enrolled at the time of the study.

Setting and Apparatus

Both phases of the study were conducted in the Michael Glenn Research Laboratory in the Howard University Department of Psychology. A Vrije Universiteit Ambulatory Monitoring System version 4.6 impedance cardiography system was employed to collect from participants: heart rate (interbeat interval, IBI) and heart rate variability (respiratory sinus arrhythmia, RSA).

Independent Variables

Adverse Childhood Experiences (ACE) Scale

Kaiser Permanente's Health Appraisal Center and the CDC compiled questions from published surveys to craft the ACE scale (Felitti et al., 1998). The ACE scale asks participants if they have experienced specific examples of types of childhood abuse, neglect, or household dysfunction (Felitti et al., 1998; Dong et al. 2004). Abuse items include specific experiences of emotional, physical, and sexual abuse (Felitti et al., 1998; Dong et al. 2004). Neglect items include examples of emotional and physical neglect (Felitti et al., 1998; Dong et al. 2004). The ACE scale included items which the CDC and Kaiser refer to as household dysfunction items, which include examples of the following circumstances occurring in the household: substance abuse, domestic violence, criminal household member, mentally-ill family member, parental marital discord. The scale includes a total of ten items.

Cross Racial Identity Scale (CRIS)

Vandiver, Fhagen-Smith, Cokley, Cross, and Worrell (2001) operationalized the identities of the Nigrescence Model into the Cross Racial Identity Scale (CRIS). Vandiver, Cross, Worrell, and Fhagen-Smith (2002) validated the CRIS. Two Pre-Encounter identities (Self-Hatred and Miseducation) and Internalization identities (Afrocentric and Multiculturalist) will be utilized in this study. The self-hatred subscale measures the extent to which participants hold negative attitudes about themselves because of their Black identity. The miseducation subscale measures the extent to which participants adopt negative stereotypes about Black people. The Afrocentric subscale measures the extent to which participants believe African Americans should adopt traditions and principles from Africa. The multiculturalist subscale measures the extent to which participants feel pride in their Black identity but also see value in engaging with other cultures. Responses were indicated on a 7-point Likert scale with options ranging from *strongly disagree* to *strongly agree*. Each subscale includes five items.

Dependent Variables

Heart rate/Interbeat Intervals

Heart rate (HR) is a metric of rate influenced by a number of factors including both the sympathetic and parasympathetic nervous systems (Allen, Chambers, Towers, 2007). Heart rate is the number of times the heartbeats in a minute. During a resting period, heart rate typically slows, therefore HR is less rapid at rest than during physical exertion. Elevated resting heart rate is associated with poorer heart health and increases in aerobic fitness are associated with slower resting heart rate.

Interbeat intervals (IBI) represent an alternative index of cardiac rate. IBI is the basis for calculating heart rate variability. The interbeat interval is the number of milliseconds between each heartbeat. During a resting period, the intervals between each heartbeat increases since the heart does not beat as often. This lends to higher interbeat interval values at rest since more milliseconds pass between each heartbeat at rest. EKGs calculate IBI based on the distance between R-spikes, which are associated with atrial and ventricular depolarization and repolarization and considered a “reliable index of cardiac timing” (Allen et al., 2007). The ICG used these IBIs to calculate the variability in timing between each heartbeat, known as heart rate variability.

Heart-rate variability

Variations in the IBI from beat to beat constitute the basis for indices of heart rate variability (HRV). A host of indices of variability are used in research and clinical practice (Allen et al, 2007). Frequency domain measures are based on Fourier transformations of IBI values (Allen et al, 2007). Many of the time domain measures are based on averages, standard deviations, root mean square of successive differences and natural logs (Allen et al, 2007).

HRV has been researched as an index relating “autonomic function and reactivity” to heart disease, hypertension, major depression, anxiety, and other conditions (Allen et al., 2007). During resting state, increased variability between beat-to-beat intervals of the heart is associated with positive cardiac autonomic regulation, while decreased variability between beat-to-beat intervals is associated with cardiac autonomic dysregulation. The present study will use an index of heart rate variability known as respiratory sinus arrhythmia (RSA). RSA is generally reputed to be a direct metric of the parasympathetic nervous system (Allen et al., 2007). RSA is calculated by the “natural log of band-limited (.12–.40 Hz) variance of IBI time series” (Allen et al., 2007). By incorporating the influence of breath (which the vagus also regulates) on the sinoatrial node, RSA is considered a refined index of the vagus’ control on the heart (Porges, 1995; Allen et al., 2007). HRV and RSA will be spoken of interchangeably in the present manuscript, although RSA is one of the indexes of HRV.

Procedure

The study had two phases. In the first phase, participants entered a research lab in Howard University’s psychology department. A research assistant explained the study to participants. Participants read and signed consent forms. Participants then completed questionnaires which included demographic questions, the ACE scale, and the CRIS. In the second phase of the study, participants returned to the lab another day. Research assistants connected an impedance cardiography monitor to participants. Research assistants instructed participants to sit and rest for fifteen minutes while watching a video of ocean waves. Heart rate data was collected from participants as they rested.

CHAPTER 4: RESULTS

Preliminary Analyses

Psychometric Properties

<u>ACE Scale</u>

Participants marked "Yes" or "No" next to each type of abuse, neglect, and household dysfunction to indicate whether or not they had that experience. "Yes" responses were coded as 1, and "no" responses were coded as 0. The number of Yes responses were summed to create an ACE composite score for each participant. The least possible score was 0, and the highest possible score was 10. ACE scores ranged from 0-8 (*M* = 1.91, *SD* = 1.77). Prevalence rates of each category of abuse for this sample are listed in Table 1.

Table 1. Participant ratings of adverse childhood experiences

Category	n	%
Abuse		
Emotional	10	22
Physical	6	13
Sexual	8	17
Neglect		
Emotional	9	20
Physical	0	0
Household Dysfunction		
Parental Marital Discord	27	59
Domestic Violence	4	9
Substance Abuse	6	13
Mental Illness	10	22
Criminal Household Member	8	17

<u>Cross Racial Identity Scale</u>

The Self-Hatred, Miseducation, Afrocentric, and Multiculturalist subscales of the CRIS were used in the calculations of this study. Participants rated on a 7-point Likert scale the extent to which they agreed with each item with high numbers representing greater subscription to that attitude. Participants' responses yielded acceptable Cronbach alpha reliability coefficients for each subscale: Self-Hatred ($\alpha = .88$), Miseducation ($\alpha = .77$), Afrocentric ($\alpha = .87$), Multiculturalist ($\alpha = .87$). Participants' responses for each subscale were summed to create subscale composite scores: Self-Hatred ($M = 8.89$, $SD = 5.56$), Miseducation ($M = 12.87$, $SD = 5.87$), Afrocentric ($M = 16.97$, $SD = 6.37$), Multiculturalist ($M = 27.74$, $SD = 6.04$). The lowest possible composite was 5, and the highest possible composite was 35.

Resting Cardiac Data

Participants were instructed to rest for 15 minutes while watching a neutral stimulus as an impedance cardiography monitor recorded heart rate data. The researcher prepared the resting cardiac data for analyses in the Vrije Universiteit - Data Analysis Management Software (VU-DAMS) computer software. Upon opening a resting cardiac data file in VU-DAMS for the first time, the software ran three analyses on the EKG signal. The first of these analyses detected and marked data with missing data or clipping of the EKG signal. The second analysis detected R-peaks of the EKG signal. The third analysis checked duration of each interbeat interval in relation to surrounding interbeat intervals and flagged highly and moderately suspicious interbeat intervals. The researcher manually inspected IBI marked highly suspicious in the context of surrounding IBI. The participants' records were checked to determine if movement or loss of electrode contact was responsible for questionable IBI values. The researcher manually deleted the highly suspicious R-peaks.

For each participant, employing the VU-DAMS software, the researcher manually scored epochs of resting cardiac activity. The researcher portioned off the first minute of the resting period, the subsequent three minutes of the resting period, the next minute of the resting period, the next three minutes of the resting period, the next minute of the resting period, and the last three minutes of the resting period. The VU-DAMS software calculated average inter-beat-intervals, average heart rate, and average respiratory sinus arrhythmia for each 3-minute epoch. The researcher used the middle 3-minute epoch of participants' heart rate data to test the hypotheses for the present study. As seen in Table 2, during this period the average heart rate was 75.81 (*SD* = 10.17 bpm), the mean interbeat interval was 809.81 msec (*SD* = 113.54 ms), and the average respiratory sinus arrhythmia was 53.93 msec (*SD* = 24.93 msec).

Relationships Among Resting Cardiac Data

The resting cardiac data for the three measurement epochs was exported from VU-DAMS to a spreadsheet and imported from the spreadsheet to IBM SPSS Statistics (SPSS). As one test of these measures of cardiac activity, we obtained correlations among the measures within and between measurement epochs. We anticipated that heart rate and IBI values would evidence a strong negative correlation. Since RSA is an indirect measure of cardiac parasympathetic activity, we expected it to correlate positively with IBI and negatively with heart rate. In general, heart rate and heart rate variability indices correlated as expected, as depicted in the Appendix. IBI values were negatively correlated with heart rate values. Because of the strength of these relationships, IBI only will be reported in examining relationships with identity and ACE prevalence. Within each epoch, RSA was expected to correlate positively with IBI and negatively with heart rate. In several instances these correlations were significant and in all cases, they were in the expected directions. Table 3 shows the correlations between heart rate, interbeat intervals, and respiratory sinus arrhythmia for the minute three minute epoch, which was the period used to test the hypotheses of the present study.

Table 2. Descriptive statistics for variables

	ACE Total	Self-Hatred	Miseducation	Afrocentric	Multiculturalist	HR/IBI	HRV (RSA)
M	1.91	8.89	12.87	16.97	27.74	75.81 / 809.81	53.93
SD	1.77	5.56	5.87	6.37	6.04	10.17 / 113.54	24.93
Min	0	5	5	6	5	52.83 / 611.85	9.13
Max	8	29	28	35	35	98.41 / 1137.98	127.74
Range	8	24	23	29	30	45.58 / 526.13	118.62

Table 3. Correlations between heart rate, interbeat intervals, and respiratory sinus arrhythmia.

	HR	IBI	RSA
HR	1		
IBI	-0.987**	1	
RSA	-0.351*	0.333*	1

Note. * < .05. ** < .01

Hypotheses 1 and 2: Cardiac Activity and Adverse Childhood Experiences

Contrary to expectations, adverse childhood experience prevalence did not significantly correlate with resting interbeat interval averages, $r = .20$, $p > .05$, nor with resting heart rate variability (respiratory sinus arrhythmia), $r = .14$, $p > .05$. Thus, neither Hypothesis 1 nor Hypothesis 2 was supported.

Moderating Roles of Racial Identity and Gender on the Relationship Between ACE Prevalence and IBI and HRV

Tests of Assumptions for Ordinary Least Squares Regression Analyses

Hayes (2015) recommends that ordinary least squares analyses should be used when the assumptions of linearity, independent residual values, homoscedasticity, normally distributed residual values, and absence of outliers are met. We tested each of these assumptions before employing this procedure to test the third and fourth hypotheses.

Linearity

Linearity refers to the assumption that the predictor variable and outcome variable can be estimated by a straight line. The scatterplot displayed in Figure 3 below illustrates that the adverse childhood experience totals (ACE_Total) and average inter-beat intervals for the middle third of the resting period share a linear relationship.

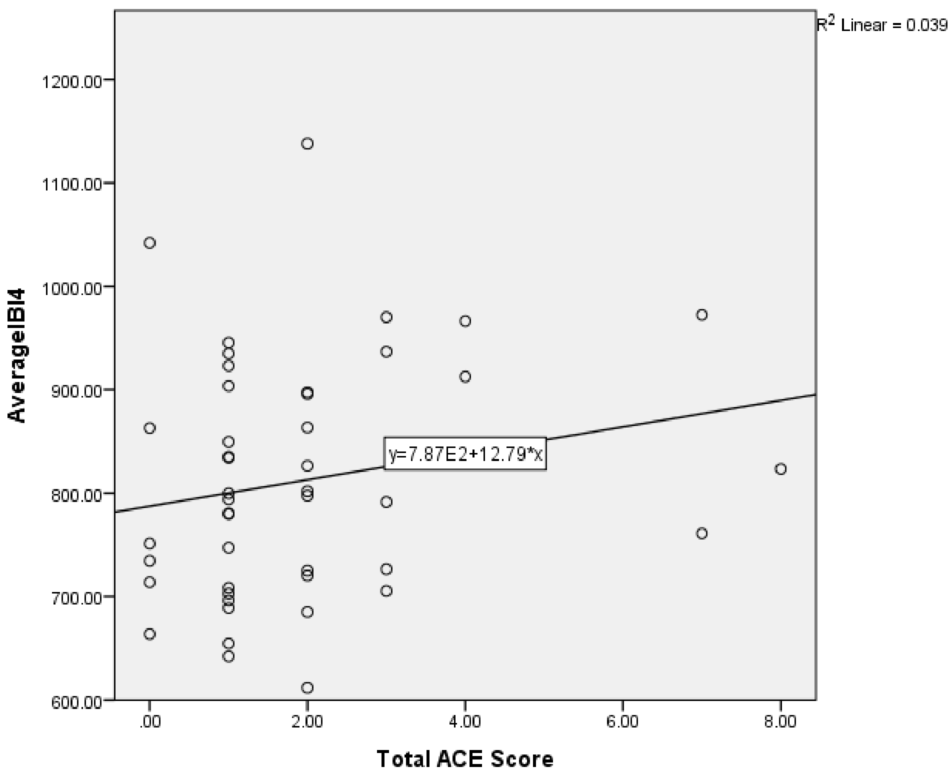

Figure 3. Scatterplot and fit line depicting the linear relationship between adverse childhood experience totals and average inter-beat intervals for the middle third of the resting period.

Additionally, the scatterplot and fit line displayed in Figure 4 illustrate that the sample's adverse childhood experience totals and average respiratory sinus arrhythmia during the middle third of the resting period (RSA_4) share a linear relationship. No nonlinear relationships were anticipated or revealed in these graphs.

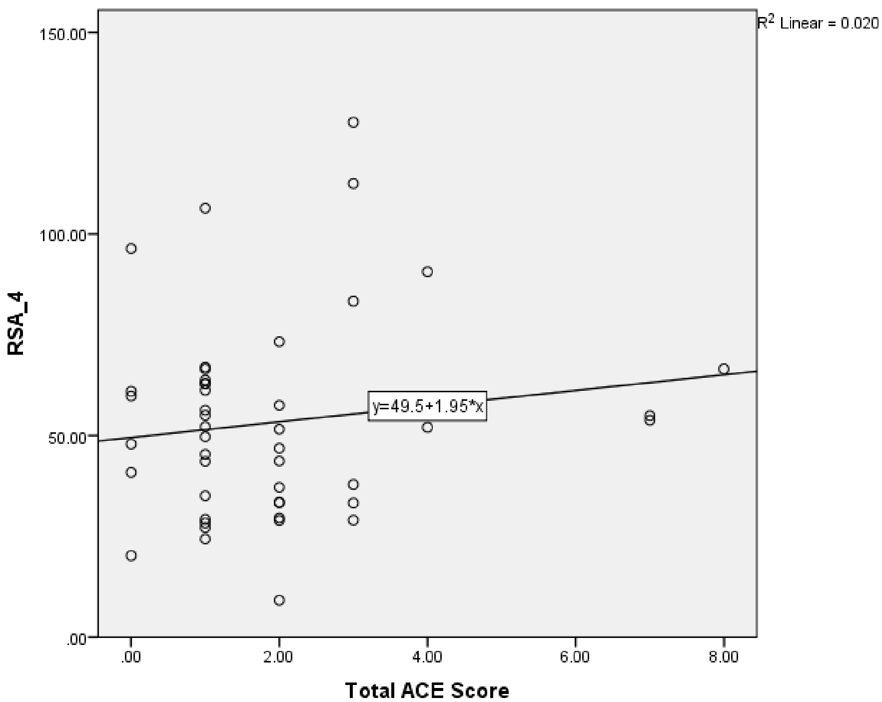

Figure 4. Scatterplot and fit line depicting the linear relationship between adverse childhood experience totals and average respiratory sinus arrhythmia for the middle third of the resting period.

Independent Residual Values

Residuals refer to the amount of distance/deviation, known as error, between each data point and the predicted regression line. An assumption of regression is that the errors associated with observations (individual data points) are independent (uncorrelated). A Durbin-Watson test was conducted in SPSS to test that the values of the residuals of ACE composites and average IBIs are independent. The resulting Durbin-Watson statistic of 1.65, which is greater than 1 and less than 3, illustrates that the values of the residuals are independent. Another Durbin-Watson test was conducted to test that the values of the residuals of ACE composites and average RSA are independent. The resulting Durbin-Watson statistic of 1.76, which is greater than 1 and less than 3, illustrates that the values of the residuals are independent.

Homoscedasticity

The variance of the residuals should be constant for the assumption of homoscedasticity to be met. As depicted in Figure 5 in the scatterplot of ACE Total and IBI residuals below, the data points appear more random than in a funnel-formation. This suggests that the residuals are equally distributed.

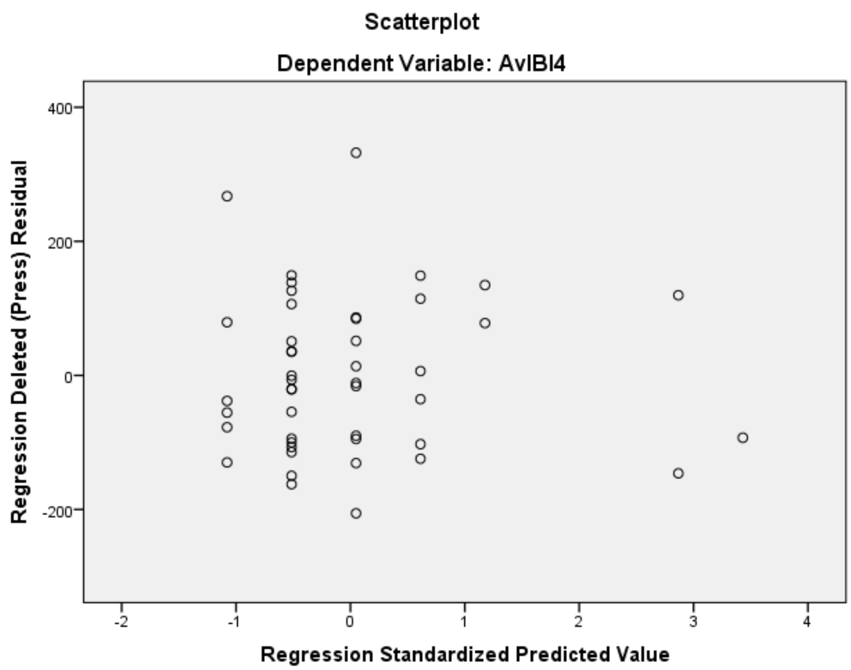

Figure 5. Scatterplot of ACE totals and average IBI residuals

Additionally, as depicted in Figure 6 in the scatterplot of ACE Total and RSA residuals, the data points appear more random than in a funnel-formation. This suggests that the residuals are equally distributed.

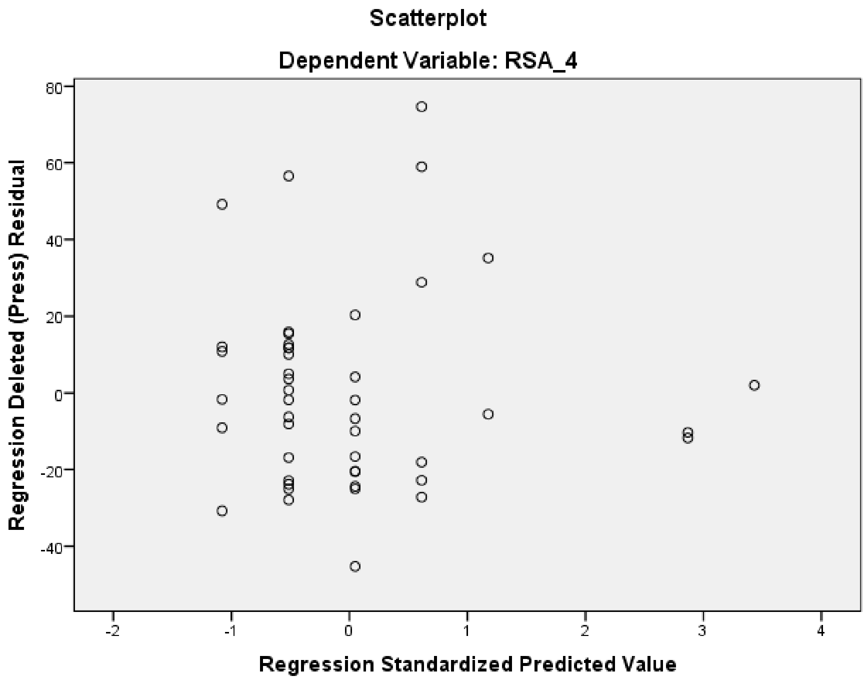

Figure 6. Scatterplot of ACE totals and average RSA residuals

<u>Normally Distributed Residuals</u>

As depicted in Figure 7 in the P-P plot, the residuals fall along the line, suggesting that the residuals are normally distributed.

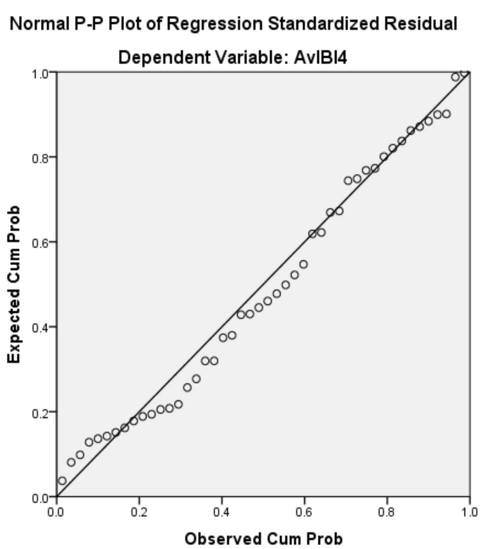

Figure 7. P-P plot of the residuals of average IBI

Additionally, as depicted in Figure 8 in the P-P plot below, the residuals fall along the line, suggesting that the residuals are normally distributed.

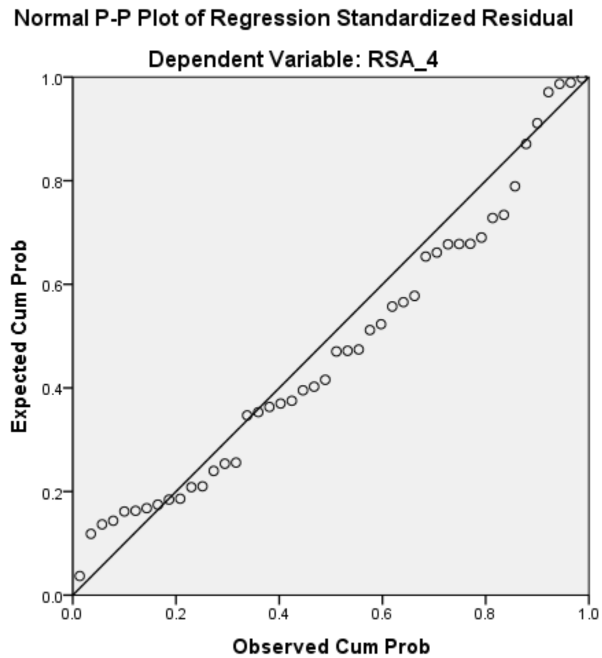

Figure 8. P-P plot of the residuals of average RSA

Absence of Outliers

Cook's Distance tests were conducted in SPSS, revealing no significant outliers for ACE Totals and IBIs or for ACE Totals and RSA (no Cook's Distance statistic values greater than 1).

Statistical Model for Testing Moderated Relationships

Andrew F. Hayes' Model 3 moderation analyses were performed to determine if racial identity moderated the relationship between ACE prevalence and resting cardiac activity, as indexed by interbeat interval averages and RSA. This model is depicted in Figure 9. Using this model, the researcher was also able to determine if racial identity, gender, or the interaction of these two variables impacted the relationship between ACE prevalence and resting cardiac activity. Model three also determines if each moderator is a significant predictor of the outcome variables. Separate analyses were executed for each dimension of racial identity and IBI and RSA.

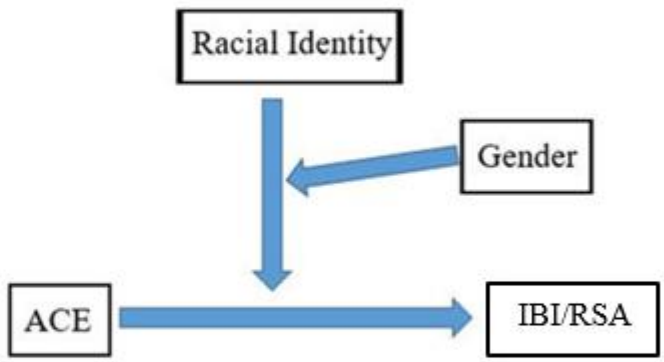

Figure 9. Conceptual model for the moderation analyses

Racial Identity, ACE Prevalence, and IBI

Multiculturalist

The Model 3 moderation analysis was performed between the dependent variable (resting interbeat interval averages) and the independent variable (adverse childhood experience prevalence) with Multiculturalist racial identity ratings as a moderator and gender moderating the influence of multicultural attitudes. The moderation analysis revealed that the overall model significantly predicted average IBI, $F(7, 36) = 3.00$, $p < .05$. The R^2 for the model was .37. However, the interaction between ACE prevalence and Multiculturalist ratings did not significantly predict average IBI, $t = 1.18$, $p > .05$. Additionally, the interaction between ACE prevalence, Multiculturalist ratings, and gender did not significantly predict average IBI, $t = -1.02$, $p > .05$. The individual relationship between ACE prevalence and average IBI was insignificant ($t = -1.12$, $p > .05$). However, Multiculturalist ratings ($t = -2.71$, $p < .05$) and gender ($t = -2.91$, $p < .05$) each significantly predict average IBI independently.

Afrocentric

The Model 3 moderation analysis was performed between average IBI and ACE prevalence with Afrocentric racial identity ratings as a moderator and gender moderating the influence of Afrocentricity. The moderation analysis revealed that the overall model significantly predicted average IBI, $F(7, 36) = 2.89$, $p < .05$. R^2 for the model was .36. However, the interaction between ACE prevalence and Afrocentricity ratings did not significantly predict average IBI, $t = .96$, $p > .05$. Additionally, the interaction between ACE prevalence, Afrocentricity ratings, and gender did not significantly predict average IBI, $t = -1.01$, $p > .05$. The individual relationships between the predictors and average IBI were not significant: ACE prevalence ($t = -0.91$, $p > .05$), Afrocentricity ratings ($t = -1.78$, $p > .05$), gender ($t = -1.87$, $p > .05$).

Self-Hatred

A moderation analysis was performed between resting IBI and ACE prevalence with self-hatred racial identity ratings as a moderator and gender moderating the influence of self-hatred. The moderation analysis revealed that the model did not significantly predict interbeat interval averages, $F(7, 36) = 1.20$, $p > .05$. R^2 for the model was .19. Additionally, the interaction between ACE prevalence and Self-Hatred ratings did not significantly predict average IBI, $t = -.70$, $p > .05$. Furthermore, the interaction between ACE prevalence, Self-Hatred ratings, and gender did not significantly predict average IBI, $t = .69$, $p > .05$. The individual relationships between the predictors and average IBI were not significant: ACE prevalence ($t = .76$, $p > .05$), Self-Hatred ratings ($t = .97$, $p > .05$), and gender ($t = .15$, $p > .88$).

Miseducation

The Model 3 moderation analysis was performed between resting IBI and ACE prevalence with Miseducation racial identity ratings as a moderator and gender moderating the influence of Miseducation. The moderation analysis revealed that the overall model did not significantly predict average IBI, $F(7, 36) = 2.08$, $p > .05$. R^2 for the model was .29. Additionally, the interaction between ACE prevalence and Miseducation ratings did not significantly predict average IBI, $t = -1.26$, $p > .05$. Furthermore, the interaction between ACE prevalence, Miseducation ratings, and gender did not significantly predict average IBI, $t = .97$, $p > .05$. The individual relationships between the predictors and average IBI were not significant: ACE prevalence ($t = 1.52$, $p > .05$), Miseducation ratings ($t = .48$, $p >.05$), and gender ($t = -0.13$, $p > .05$).

Racial Identity, ACE Prevalence, and RSA

Afrocentric

The Model 3 moderation analysis was performed between the dependent variable (resting respiratory sinus arrhythmia) and the independent variable (adverse childhood experience prevalence) with Afrocentric racial identity ratings as a moderator and gender moderating the influence of Afrocentricity. The moderation analysis revealed that the overall model did not significantly predict RSA, $F(7, 36) = 2.11$, $p > .05$. R^2 for the model was .29. However, the interaction between ACE prevalence and Afrocentricity ratings significantly predicted average RSA, $t = 2.20$, $p < .05$. Furthermore, the interaction between ACE prevalence, Afrocentric ratings and gender significantly predicted average RSA, $t = -2.26$, $p < .05$. The 3-way interaction, depicted in Figure 10, added 10% more explanatory variance in average RSA, R^2 *change* = .10, $p < .05$. In Figure 10, 1 represents the male participants and 2 represents the female participants. The conditional effect of ACE prevalence on RSA was significant among male participants with Afrocentric ratings one standard deviation below the mean, $t = -2.09$, $p < .05$. ACE prevalence individually significantly predicts average RSA, $t = -2.26$, $p < .05$. Neither

Afrocentricity ratings (t = -1.70, p > .05) nor gender (t = -1.61, p > .05) significantly predicted average RSA independently.

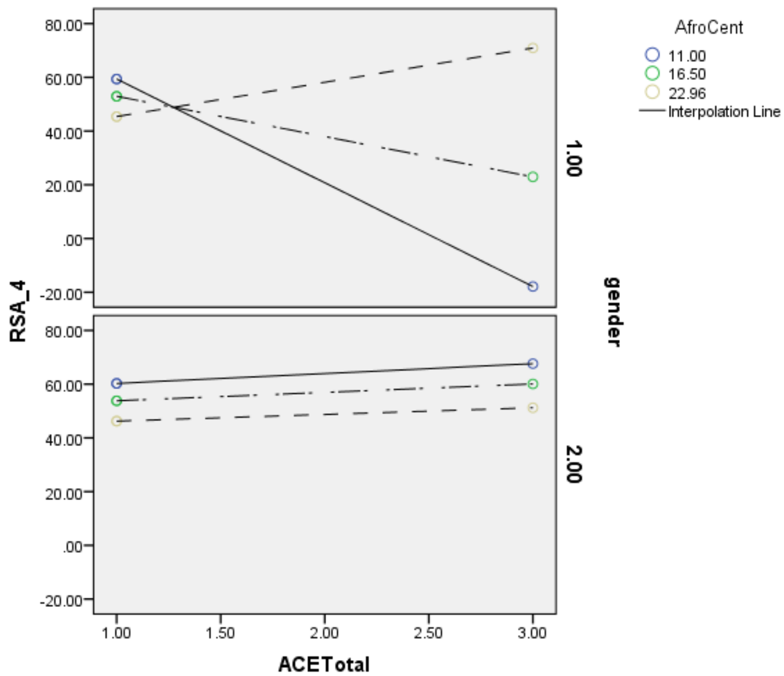

Figure 10. Interactions between ACE prevalence and racial identity on RSA per gender. 1 = men, 2 = women. Lines represent Afrocentricity ratings at the mean, one standard deviation above the mean, and one standard deviation below the mean.

Miseducation

The Model 3 moderation analysis was performed between resting RSA and ACE with Miseducation racial identity ratings as a moderator and gender moderating the influence of miseducation. The moderation analysis revealed that the overall model did not significantly predict RSA, $F(7, 36) = 1.18$, p > .05. R^2 for the model was .19. Additionally, the interaction between ACE prevalence and Miseducation ratings did not significantly predict average RSA, t = 1.83, p > .05. However, the interaction between ACE prevalence, Miseducation ratings and gender significantly predicted average RSA, t = -2.06, p < .05. This 3-way interaction added 10% more explanatory variance in RSA, R^2 *change* = .10, p < .05. The individual relationships between the predictors and average RSA were not significant: ACE prevalence (t = -1.78, p >.05), Miseducation ratings (t = -1.76, p > .05), and gender (t = -1.74, p > .05).

Self-Hatred

A Model 3 moderation analysis was performed between resting respiratory sinus arrhythmia and ACE prevalence with self-hatred racial identity ratings as a moderator and gender moderating the influence of self-hatred. The moderation analysis revealed that the model did not significantly predict respiratory sinus arrhythmia, $F(7, 36) = .65$, p >.05. R^2 for the model was .11. Additionally, the interaction between ACE prevalence and Self-Hatred ratings did not significantly predict RSA, t = 1.17, p > .05. Furthermore, the interaction between ACE prevalence, self-hatred ratings, and gender did not significantly predict RSA, t = -1.02, p > .05. The individual relationships between the predictors and RSA were not significant: ACE prevalence (t = -1.23, p > .05), Self-Hatred ratings (t = -.89, p > .05), and gender (t = -.67, p > .05).

Multiculturalist

The Model 3 moderation analysis was performed between resting RSA and ACE prevalence with Multiculturalist racial identity ratings as a moderator and gender moderating the influence of multicultural attitudes. The moderation analysis revealed that the overall model did not significantly predict RSA, $F(7, 36) = 1.76$, p > .05. R^2 for the model was .26. Also, the interaction between ACE prevalence and Multiculturalist ratings did not significantly predict average RSA, t = -.09, p > .05. Further, the interaction between ACE prevalence, Multiculturalist ratings, and gender did not significantly predict RSA, t = -.34, p > .05. The individual relationships between the predictors and RSA were not significant: ACE prevalence (t = .04, p >.05), Multiculturalist ratings (t = -1.02, p > .05), and gender (t = -0.92, p > .05).

CHAPTER 5: DISCUSSION

Contrary to expectations, adverse childhood experience prevalence was not found to be related to average resting interbeat intervals or for RSA in this sample. However, the overall regression model which included ACE total, Multiculturalist attitudes, gender, and all interaction terms significantly predicted resting interbeat interval averages. However, participants with high multiculturalist attitudes exhibited low resting interbeat interval averages, which was contrary to expectations. Also, women had decreased resting interbeat interval averages according to the model including Multiculturalist and IBI. The overall model that included ACE total, Afrocentric attitudes, gender, and all interaction terms also significantly predicted resting interbeat interval averages. However, the analysis showed that participants with adverse childhood experiences and Afrocentric attitudes were not more likely to have decreased interbeat interval averages, that is, faster heart rates.

Participants with adverse childhood experiences and Afrocentric attitudes were more likely to have decreased resting heart rate variability. Furthermore, in addition to adverse childhood experience prevalence and Afrocentric attitudes, considering gender added 10% more explanatory variance in predicting resting heart rate variability. Notably, male participants with adverse childhood experiences and low Afrocentricity ratings were more likely to have decreased resting heart rate variability. Additionally considering gender in addition to ACE prevalence and miseducation attitudes added 10% more explanatory variance in predicting resting heart rate variability. The remaining identity measures did not predict or interact to predict IBI or RSA.

Adverse Experiences and Cardiac Activity

This study did not find ACE prevalence to be related to resting IBI. This is contrary to expectations because Pretty et al. (2013) used logistic regression and found that four or more adverse childhood experiences had a significant effect on heart rate, which is highly correlated with IBI. In the present sample, only 11% of the participants reported four or more adverse experiences. Greater variability in ACE scores may be necessary for this relationship to emerge.

Previous studies have examined African Americans' cardiovascular responses to stressful stimuli (Jones, Harrell, Morris-Prather, Thomas, & Omowale, 1996; Morris-Prather et al., 1996; Sutherland & Harrell, 1986; Bowen-Reid & Harrell, 2002). Participants in Jones, Harrell, Morris-Prather, Thomas, and Omowale (1996) either viewed or imagined both blatant and subtle illustrations of racism while the researchers recorded their physiological responses. Jones et al. (1996) found significant changes in heart rate during the illustrations, most notably during the blatant racism condition. Sutherland and Harrell (1986) had participants imagine fearful, racially noxious, and neutral scenes while their physiological responses were recorded. Sutherland and Harrell (1986) found that "the fearful and racially noxious scenes elicited comparable increases" in heart rate activity. Bowen-Reid and Harrell (2002) examined the effects of racist events and perceived racial stress on cardiovascular reactivity--namely, blood pressure and heart rate reactivity. Bowen-Reid and Harrell (2002) found that frequency of racist encounters in one's lifetime and level of perceived racial stress each negatively predicted heart rate reactivity in response to a psychological stressor (mirror tracer task). In fact, all of these studies examined in the moment heart rate reactivity to stressful stimuli. In contrast, the present thesis study examined subsequent resting heart rate data long after childhood adversity. This methodological difference may account for the contrasting results. However, evidence still suggests that particularly adverse experiences may result in relatively enduring changes in physiological activity (Pretty et al., 2013).

This study also did not find ACE prevalence to be related to resting HRV. This is contrary to expectations in light of the Bailey et al. (2017) report of disparities in heart disease between African Americans and Caucasian Americans. Additionally, Bor et al. (2018) found that Black participants exposed to police killings of unarmed Black Americans in their same state was associated with an increase in poor mental health days. Long term mental health influences could have impact on physiology; thus, the null relationship between ACE prevalence and RSA is contrary to expectations.

Dong et al. (2004) found a relationship between ACE prevalence and self-reported heart disease. Specifically, Dong et al. (2004) found a dose-response relationship in that for every increase in ACE score, participants were more 20% more likely to report heart disease. Hence, respondents in Dong et al. (2004) with seven or more ACE were three times as likely to report heart disease than those with no ACE. An aim of the present study was to use a neural mechanism to identify early cardiac autonomic dysregulation in a sample of young adults; however, the hypothesis was unsupported.

Also, the present study's average ACE score being two is a potential limitation. Eleven percent of the sample of forty-six had ACE scores of 4 or more, which is likely where effects on RSA would be seen. Dong et al. (2004) found that endorsement of any type of adverse experience except marital discord increased the likelihood of reporting heart disease. Not only is the present sample's mean ACE score two, but 59% of the sample endorsed marital discord as an ACE. In light of Dong et al. (2004)'s findings of marital discord alone not having a significant effect on increasing the likelihood of reporting heart disease, taking out marital discord from the present study's ACE scores would bring the mean closer to one ACE score, thus further limiting ability to see effects.

The present study's result of ACE prevalence not relating to HRV provides no support for Polyvagal Theory's prediction that adverse experiences are related to decreased vagal tone. The finding is additionally surprising because Miskovic et al. (2009) found childhood maltreatment to be related to decreased RSA and initial recording and six month follow-up. However, the effect of childhood maltreatment on RSA was no longer significant after controlling for socioeconomic status. It is possible that SES is a more proximal cause of decreased RSA than childhood maltreatment exposure and severity as rated by the researchers in that study.

Jovanovic et al. (2011) found that the children of women who were abused as children had decreased LF/HF HRV. The ratio of low to high frequency variability cardiac activity has been advanced as a measure of autonomic balance between the sympathetic and parasympathetic cardiac branches (Allen et al., 2007). The interplay between these two branches on cardiac functioning is complex. The branches can be co-activated, co-inhibited, function independently, or show an inverse relationship (Berntson et al., 1994). Future studies should consider both branches of the cardiac autonomic system, as well as their interactions when studying the impact of early adverse experiences.

Psychological Factors as a Moderator of Effects

Studies have found psychological factors moderating the effects of adverse experiences on cardiac autonomic regulation and physiological stress response. Dong et al., (2004) found respondents who endorsed psychological and traditional risk factors for heart disease reported more likely to have heart disease than those without those risk factors. Psychological and traditional risk factors accounted for 10% of the variance in self-reported heart disease when using ACE prevalence to predict heart disease (Dong et al., 2004). Furthermore, respondents who endorsed psychological risk factors for IHD (i.e., depressed affect and anger) reported higher prevalence of IHD than participants that endorsed only traditional risk factors (diabetes, hypertension, smoking, BMI, physical inactivity) (Dong et al., 2004). These results highlighted a need to consider psychological factors in using adverse childhood experiences to predict cardiac autonomic dysregulation.

Zilioli et al. (2016) found that self-esteem reduced the effect of childhood adversity for morning cortisol and cortisol slope. The present study's finding that participants with adverse childhood experiences and Afrocentric attitudes were more likely to have decreased resting heart rate variability is consistent with Zilioli et al. (2016). Additionally, the present study's findings that ACE prevalence, miseducation, and gender predict RSA were consistent with Zilioli et al. (2016). The null results relating Self-Hatred and Multiculturalist attitudes to RSA were contrary to expectations. However, Zilioli et al., (2016) and the present study use stress response metrics from two different physiological systems. Namely, Zilioli et al., (2016) uses cortisol, which in the HPA axis is a neuroendocrine chemical released in response to stress. The present study uses respiratory sinus arrhythmia, which is widely viewed as an index parasympathetic nervous system activation (Allen et al., 2007).

Neblett and Roberts (2013) studied the moderating role of racial identity on the effects of racial discrimination on heart rate variability (RSA). The African-American college student participants listened to audio vignettes depicting blatantly and subtly racist interactions using White and Black perpetrators (Neblett and Roberts, 2013). Participants with moderate and high levels of positive feelings about their Black identity (i.e., private regard) exhibited decreased vagal tone (RSA) while listening to the blatant racism condition when the perpetrator was Black compared to the increased vagal tone during the recovery period (Neblett and Roberts, 2013). Additionally, when listening to the blatant racism interaction with the White perpetrator, participants with low levels of positive feelings about their Black identity exhibited decreased vagal tone compared to the increased vagal tone during the recovery period (Neblett and Roberts, 2013). As noted earlier, Neblett and Roberts (2013) recorded heart rate variability responses while participants listened to vignettes. The present thesis study examined resting heart rate variability in individuals long after childhood adversity was experienced. In this respect, the studies are not fully comparable.

Limitations

The present study has some limitations. Dong et al. (2004) included 17,337 participants, Fuller-Thompson et al. (2010) included 13, 093 participants, and Pretty et al. (2013) included 1,234 participants. Comparing studies with sample sizes of this magnitude with the present study's sample size of 46 may account for some differences. Also, Dong et al. (2004) found that heart disease prevalence was twice as high in respondents over 65 years old. The use of college-age students may have decreased ability to see effects than examining a sample with older participants. Further, the use of college students may be a limitation of the study since Dong et al. (2004) found that individuals with less than high school education were two times more likely to report heart disease than college graduates. Though an aim of the present study was to check for early signs of cardiac autonomic dysregulation in a college-aged sample, perhaps more effects would be seen in a high school sample.

Future Directions

More research is needed to further explore the ideas presented in this study. In light of Dong et al. (2004)'s finding that less educated respondents were more likely to report heart disease than those with college education, future studies including samples of young adults without college education may yield more variation in early signs of cardiac autonomic dysregulation. Additionally, a sample of high school students may be more appropriate in studying the role of racial identity as Erikson theorizes that adolescents are in a stage of working out their personal identities (Berzoff, Melano Flanagan, & Hertz, 2016). Also, incorporating the ratio of low to high frequency variability cardiac activity (LF/HF) into future analyses would lend more refined descriptions of sympathetic and parasympathetic system activity and the complex interactions between the two as a result of early adverse experiences. A larger sample with a higher mean of adverse childhood experience prevalence may lend different results. Researchers should continue to explore this topic to expand the literature and information available to professionals working in the field of psychology.

APPENDIX

Correlations Between Each Three-Minute Epoch of the Resting IBI, HR, and RSA

Correlations

		AverageIBI2	AverageHR2	RSA_2	AverageIBI4	AverageHR4	RSA_4	AverageIBI6	AverageHR6	RSA_6
AverageIBI2	Pearson Correlation	1	-.983**	.210	.981**	-.969**	.313*	.955**	-.943**	.319*
	Sig. (2-tailed)		.000	.161	.000	.000	.034	.000	.000	.031
	N	46	46	46	46	46	46	46	46	46
AverageHR2	Pearson Correlation	-.983**	1	-.233	-.961**	.978**	-.333*	-.938**	.951**	-.327*
	Sig. (2-tailed)	.000		.120	.000	.000	.024	.000	.000	.027
	N	46	46	46	46	46	46	46	46	46
RSA_2	Pearson Correlation	.210	-.233	1	.195	-.214	.842**	.172	-.179	.587**
	Sig. (2-tailed)	.161	.120		.195	.153	.000	.253	.235	.000
	N	46	46	46	46	46	46	46	46	46
AverageIBI4	Pearson Correlation	.981**	-.961**	.195	1	-.987**	.333*	.968**	-.957**	.341*
	Sig. (2-tailed)	.000	.000	.195		.000	.024	.000	.000	.020
	N	46	46	46	46	46	46	46	46	46
AverageHR4	Pearson Correlation	-.969**	.978**	-.214	-.987**	1	-.351*	-.959**	.970**	-.346*
	Sig. (2-tailed)	.000	.000	.153	.000		.017	.000	.000	.019
	N	46	46	46	46	46	46	46	46	46
RSA_4	Pearson Correlation	.313*	-.333*	.842**	.333*	-.351*	1	.313*	-.322*	.770**
	Sig. (2-tailed)	.034	.024	.000	.024	.017		.034	.029	.000
	N	46	46	46	46	46	46	46	46	46
AverageIBI6	Pearson Correlation	.955**	-.938**	.172	.968**	-.959**	.313*	1	-.988**	.404**
	Sig. (2-tailed)	.000	.000	.253	.000	.000	.034		.000	.005
	N	46	46	46	46	46	46	46	46	46
AverageHR6	Pearson Correlation	-.943**	.951**	-.179	-.957**	.970**	-.322*	-.988**	1	-.393**
	Sig. (2-tailed)	.000	.000	.235	.000	.000	.029	.000		.007
	N	46	46	46	46	46	46	46	46	46
RSA_6	Pearson Correlation	.319*	-.327*	.587**	.341*	-.346*	.770**	.404**	-.393**	1
	Sig. (2-tailed)	.031	.027	.000	.020	.019	.000	.005	.007	
	N	46	46	46	46	46	46	46	46	46

**. Correlation is significant at the 0.01 level (2-tailed).

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