ABSTRACT

Does Subjective Socioeconomic Status Relate to Health Outcomes?:
Blunted and Exaggerated Cardiovascular Responses to Stress

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Lower levels of subjective and objective socioeconomic status (SES) and stress are related to adverse cardiovascular outcomes. Individual differences in cardiovascular responses to stress has been proposed as a potential mechanism underlying this relationship. Aim: examine the relationship between cardiovascular stress reactivity and both subjective and objective SES. Study 1: 88 (67.9% female, 51.7% Caucasian and an age range = 18 to 62 years [M = 26.9, SD = 10.7]) participants completed the MacArthur Scale of Social Status, a 10-minute baseline period and a 10-minute stress task. Blood pressure (BP) and heart rate (HR) were assessed throughout the baseline and stress periods. Reactivity was calculated as: stress – average baseline for each cardiovascular parameter. Results indicated a positive relationship between both HR and systolic BP reactivity and subjective SES (r = 0.29, p = .007) and (r = 0.24, p = .027), respectively. Lower subjective SES was associated with blunted cardiovascular responses. Study 2: 123 (66.7% female, 62.6% Caucasian and an age range = 18 to 23 years [M = 19.1, SD = 0.850]) participants completed the same procedure aside from a 4-minute stress task instead of 10 minutes and the addition of a questionnaire component assessing their parents' occupational status. Both increased HR and systolic BP reactivity were related to lower objective SES (r = -0.26, p = .004) and (r = -0.22, p = .020), respectively. Individuals with lower objective SES had exaggerated cardiovascular responses; there were no significant relationships between cardiovascular responses and subjective SES. The current two study thesis contributed to competing claims regarding the directionality of the relationship between SES and cardiovascular reactivity.

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DOES SUBJECTIVE SOCIOECONOMIC STATUS RELATE TO HEALTH OUTCOMES?:
BLUNTED AND EXAGGERATED CARDIOVASCULAR RESPONSES TO STRESS

A Thesis Submitted to the Faculty of

Baylor University

In Partial Fulfillment of the Requirements for the

Honors Program

By

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Waco, Texas

May 2020

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ACKNOWLEDGEMENTS

To my Thesis Director, Dr. Ginty: Thank you for your unwavering support in my academic endeavors. I appreciate the immense time and effort you've invested in me. The opportunities that have arisen through your mentorship have enabled me to develop as a critical thinker, insightful observer and most importantly, thoughtful servant to the underserved. From the Heart of Love Clinic in Guatemala to the Baylor Behavioral Medicine Lab, our shared experiences have shaped me to be a more competent and compassionate participant in the problems facing our world today. I admire you immensely, and it has been an honor to learn from such a renowned researcher and heartfelt humanitarian.

To Dr. Young: Thank you for your contributions in cultivating my vision for studying socioeconomic status and health. Your countless hours spent offering insight throughout the process did not go unnoticed. I am so grateful to have been surrounded by such a strong role model of diligent discipline. I aspire to pursue my passions with as much perseverance, ambition and drive as you do. By way of your example, you inspire me to wholeheartedly invest in the lives of those around me.

To the Baylor Behavioral Medicine Lab: Thank you to all of the Research Assistants and Graduate Students who aided in the collection and analyses of the data. The scope of this study would not have been possible without the efforts of all involved.

To Dr. Limbers: Thank you for serving on my Defense Committee and for your invaluable input. It has been an enlightening experience to learn from your expertise in the classroom, and your dedication to the discipline of Psychology is evident and admirable.

To my family, friends and loved ones: Thank you for your ability to always encourage me in all of my endeavors. I am so blessed to have such a strong support system that enables me to pursue all of my passions, both those within reach and seemingly unimaginable. I would not be where I am today without each and every one of you.

DEDICATION

To Mom, Dad, Nana and Grandpa, exemplars of unfailing love. Thank you for giving me the strength and support to reach for the stars.

CHAPTER ONE

Introduction

Socioeconomic Status and Health

It has been hypothesized that individuals of lower socioeconomic status (SES) are at increased risk for poor physical health outcomes (Ghaed and Gallo, 2007; Quon and McGrath, 2014; Gong, Xu, & Takeuchi, 2012). For example, lower SES has been associated with worse cardiovascular health (Boylan, Cundiff, & Matthews, 2018; Sing-Manoux, Marmot, & Adler, 2005; Clark, DesMeules, Luo, Duncan, & Wielgosz, 2009). The exact mechanisms underlying the relationship between lower SES and worse health, specifically cardiovascular health, remain unknown. However, some research suggests physiological responses to stress may be one possible pathway (Carroll, Ring, Hunt, Ford, & Macintyre, 2003).

SES is a broad term that can be defined differently. For example, subjective SES is defined as an individual's perception of his position within a social hierarchy, and it is a fundamentally psychological phenomenon in that its conceptualization varies from person to person (Jackman and Jackman, 1973). Objective SES is defined as inequality in the distribution of valued goods and resources in the impersonal area of achievement, and it captures differences in opportunity, prosperity and standing observed in human populations (Ross and Mirowsky, 2008). Subjective SES tends to encompass a broader range of factors than objective SES and is considered multidimensional; it has been cited as a more comprehensive means of assessing related health outcomes (Damakakos, Nazroo, Breeze, & Marmot, 2008). In order to most precisely predict poor

health outcomes, research has indicated a need to include a psychological composite of perceived position. This is included to more accurately account for relative standing in the social hierarchy, cognitive averaging of various markers of SES as well as past and future predictions of placement (Payne, 2017). Prior research has linked subjective SES measures of perceived societal position as more important than objective SES measures, such as education, occupation and income markers, in relating to cardiovascular disease outcomes (Singh-Manoux, Marmot, & Adler, 2005; Prag, Mills, & Wittek, 2015).

Subjective and objective SES have both been related to poor health outcomes, such as coronary heart disease (for reviews see Heslop, Smith, Carroll, Macleod, Hyland, & Hart, 2001; Fiscella and Tancredi, 2008; Schultz et al., 2018), carotid atherosclerosis (Lynch, Everson, Kaplan, Salonen, & Salonen, 1998), hypertension (Carroll, Ring, Hunt, Ford, & MacIntyre, 2003; Spruill, 2010; Merritt, Bennett, Williams, Sollers, & Thayer, 2004), acute myocardial infarction (Lynch, Krause, Kaplan, Tuomilehto, & Salonen, 1997) and all-cause mortality (Lynch, Kaplan, Cohen, Tuomilehto, & Salonen, 1996; Steenland, Hu, & Walker, 2004; Lazzarino, Hamer, Stamatakis, & Steptoe, 2013). It has been proposed that cardiovascular responses to acute psychological stress (i.e., cardiovascular reactivity) may be a pathway through which SES relates to cardiovascular disease (e.g., Carroll et al., 2003).

Socioeconomic Status and Cardiovascular Reactivity

Cardiovascular disease risk consists of various contributors, such as carotid atherosclerosis and hypertension, that are implicated by exaggerated cardiovascular reactivity (Low, Salomon, & Matthews, 2009). The reactivity hypothesis poses that large magnitude cardiovascular reactions to acute psychological stress contribute to

cardiovascular disease risk (Carroll, Phillips, & Lovallo, 2011). Present research surrounding the reactivity hypothesis has largely ignored, yet implicitly assumed that low physiological reactivity in response to acute psychological stress is the more advantageous response, with no negative health or behavioral outcomes (Carroll, Phillips, & Lovallo, 2011). Recent research has found evidence to the contrary: blunted cardiovascular reactivity during stress may not be the healthier response. Blunted cardiovascular reactivity could explain the association between SES and cardiovascular disease risk (Phillips, Ginty, & Hughes, 2013).

Subjective versus Objective Socioeconomic Status and Cardiovascular Reactivity

Psychological stress is defined as "an unfavorable person-environment relationship" with "its essence [as] process and change rather than structure or stasis" (Lazarus, 1993). It has been observed that psychological stress alters cardiovascular activity and that both subjective and objective measures of SES may serve as contributing factors in the resulting responses (Steptoe et al., 2003). A recent meta-analysis examining SES and cardiovascular reactivity to acute psychological stressors found that cardiovascular reactivity as a mediator linking lower SES and poor health is not supported, but rather cardiovascular recovery from acute stress may be a more informative mechanism linking SES with morbidity and mortality (Boylan, Cundiff, & Matthews, 2018). Therefore, when examining all types of tasks, low SES is not associated with higher blood pressure and heart rate reactivity. However, sub-analyses in the meta-analysis demonstrated that higher SES is reliably associated with greater blood pressure and heart rate reactivity to acute cognitive stressors (Boylan, Cundiff, & Matthews, 2018).

Little research has examined the relationships between both subjective and objective SES and cardiovascular reactivity, in terms of systolic blood pressure and heart rate, in response to an acute psychological stress task. One study conducted among White women compared subjective and objective indicators of SES as predictors of both psychological and physical health factors and found that subjective SES served as a more consistent indicator of greater strength than objective SES for both outcome measures (Adler, Epel, Castellazzo, & Ickovics, 2000). However, this particular study failed to overcome several shortcomings of previous competing claims in the directionality of blunted or exaggerated cardiovascular responses to acute psychological stress. Examples include a lack of diversity in participants in terms of gender, age and race, absence of specifically measured cardiovascular reactivity in physical health indicators, and nonexistence of evoked acute psychological stress in a portion of the sample. Although, Adler, Epel, Castellazzo and Ickovics (2000) do offer a nuanced means of measuring social status with the subjective SES scale utilizing a ladder approach similar to that of the MacArthur Scale of Subjective Social Status and the objective SES scale including highest degree earned in education, household income and occupational category. Given prior research emphasizing the relationship between cardiovascular reactivity and acute psychological stress, it is evident that though this study provides appropriate operational definitions for both objective and subjective SES, it fails to appropriately relate them to the present physiological measures of interest.

Potential explanations for inconsistencies in the literature may include the type of stressor utilized (Lovallo, 2005), as well as potential moderating variables, such as age (Low, Salomon, & Matthews, 2009; Kudielka, Buske-Kirschbaum, Hellhammer, &

Kirschbaum, 2004), gender (Carroll, Ring, Hunt, Ford, & Macintyre, 2003) and race (Arthur, Katkin, & Mezzacappa, 2004; Jackson, Treiber, Turner, Davis, & Strong, 1999). Another potential explanation for inconsistencies could be the measurement of SES, with some studies using objective means (e.g., Merritt, Bennett, Williams, Sollers, & Thayer, 2004; Lynch, Kaplan, Cohen, Tuomilehto, & Salonen, 1996) and others using subjective means (e.g., Quon and McGrath, 2014; Prag, Mills, & Wittek, 2016).

Purpose of the Present Study

The aims of the current two study thesis were to 1) examine the relationship between cardiovascular reactivity in response to an acute psychological stress task and subjective SES and 2) examine the relationship between cardiovascular reactivity in response to an acute psychological stress task and objective SES. Due to the absence of analysis of both subjective and objective SES, the present findings contributed to the body of literature concerning the competing claims of exaggerated or blunted cardiovascular responses to acute psychological stress. Based on previous research (Singh-Manoux, Marmot, & Adler, 2005), it was hypothesized that subjective SES would be a stronger indicator of reactivity to stress in comparison to objective SES. Furthermore, in Study 1, which aimed to examine the association between subjective SES and heart rate as well as blood pressure changes in response to an acute psychological stress task, it was specifically hypothesized that increased reactivity resulting from exposure to stress would be associated with higher subjective SES (Singh-Manoux, Marmot, & Adler, 2005; Phillips, Ginty, & Hughes, 2013). Blunted cardiovascular reactivity was favored over exaggerated cardiovascular reactivity due to the most recent research opposing the reactivity hypothesis. Contrarily, in Study 2, which aimed to

examine the association between objective SES and heart rate as well as blood pressure changes in response to an acute psychological stress task, it was specifically hypothesized that there would be no significant difference in reactivity resulting from exposure to stress and objective SES (Abel, Epel, Castellazzo, & Ickovics, 2000). This prediction was based on the notion that subjective SES plays a more substantial role in predicting cardiovascular reactivity and health outcomes altogether.

CHAPTER TWO

Review of Literature

An Introduction to Socioeconomic Status

Socioeconomic status has been defined and measured in a multitude of ways. According to Rawshani, Svensson, Rosengren, Eliasson and Gudbjornsdottir (2015), it is a complex construct often conceptualized as the social standing or class of an individual. Furthermore, it reflects different aspects of social stratification, with traditional indicators at the individual level including income, education and occupation (Adler and Ostrove, 1999). It can also be viewed as a relative position on a social hierarchy or ranking on dimensions according to access to or control over valued commodities such as wealth, power and status (Mueller and Parcel, 1981). Therefore, it is a complex concept that can be interpreted from a variety of perspectives including the individual, family, neighborhood, community and overall environment.

Table 2.1 *Selected studies on the measurement of socioeconomic status.*

Study	Measurement
Mueller & Parcel (1981)	Differing units of analysis (individual versus household or family) for education and income levels
Ensminger et al. (2000)	Assessment of financial capital, human capital and social capital in adolescents and their mothers
Shavers (2007)	Table of strengths and limitations of selected SES measures; composite SES measures (e.g., income, employment, education, communications, transportation and home ownership) versus contextual SES measures (e.g., neighborhoods and other geographic areas)
Schoeni, Buchmueller, & Freedman (2011)	Use of the Panel Study of Income Dynamics to understand the socioeconomic-health gradient
Miech & Hauser (2001)	Occupation is sometimes an important mechanism linking education and health, but controlling for overall relations between SES and health may not require occupational measures when educational attainment is assessed

The most common approach in the literature has been to address socioeconomic status as a multidimensional construct, consisting of subsets such as dwelling characteristics, educational attainment, employment, income, mobility and social characteristics (Mustard and Frohlich, 1995). However, each of these contributing factors is uniquely weighted making it difficult to operationalize and measure. For example, the occupation facet of socioeconomic status has been traditionally viewed as most important due to its applicability to both individuals and households (Mueller and Parcel, 1981). In some cases, socioeconomic status may even include household possessions, which can be a more empirically representative measure in non-Western settings (Zimmer and Amornsirisomboon, 2001).

Taken alone, each of these definitions describe only a portion of the socioeconomic status domain. Another limitation is that socioeconomic status has previously ignored marked racial and ethnic differences in income at a given educational level and in wealth at a given income level (Braveman et al., 2005) as well as a lack of conceptual clarity about the essential nature of social stratification with inconsistencies in operationalizing terminology such as social structure and social class (Oakes and Rossi, 2003). A more encompassing definition of socioeconomic status has been accepted as one's access to collectively desired resources, such as material goods, money, power, friendship networks, healthcare, leisure time or educational opportunities, which enable an individual to prosper in the social world (Oakes and Andrade, 2017), all of which underlie a person's predisposition to poor health (Boylan, Cundiff, & Matthews, 2018).

Subjective and Objective Socioeconomic Status

Historically, studies on social inequalities used objective indicators about educational qualifications, occupational positions and income levels for individuals or households dating back to Max Weber's theory of social stratification, which emphasized the multidimensional nature of the concept (Hoebel, Maske, Zeeb, & Lampert, 2017). The objective means of measuring socioeconomic status, such as education, occupation and income, were first proposed to be highly correlated with one another based on the widely accepted Marxist theory of inter-relatability (Jackman and Jackman, 1973). Ultimately, objective socioeconomic status consists of composition measures, including occupation, education and income, as well as contextual measures, such as neighborhood and geographic area (Shavers, 2007).

The objective aspects may occur concurrently (Baron-Epel and Kaplan, 2009) or independently (Nobles, Weintraub, & Adler, 2013) of subjective means of measuring socioeconomic status. Subjective social status was introduced into the research domain in 2000 as an indicator of how people self-evaluate their access to socioeconomic resources in relation to other members of society and related feelings of inequality between self and others (Hoebel, Maske, Zeeb, & Lampert, 2017). While this is a seemingly new measure, early work by Richard Centers demonstrates that the incongruence between belief in position and actual status is a long-standing tradition observed in the social sciences (Hoebel, Maske, Zeeb, & Lampert, 2017). The subjective aspects of socioeconomic status reflect self-appraisal about one's location in a socioeconomic status order, perceptions of inequality and subordination in the hierarchy of a society and "cognitive averaging" of objective SES measures (Prag, Mills, & Wittek, 2016).

An important note is the difference between the experience and expression of socioeconomic status, which attempts to be captured through the categorical confines of subjective and objective socioeconomic status. The experience of subjective socioeconomic status is comprised of the assessment of current and future prospects (Singh-Manoux, Marmot, & Adler, 2005), while the expression of objective socioeconomic status consists of a position at the individual, familial and community levels (McEwen and Gianaros, 2010). Difficulties arise when researchers attempt to differentiate these various conceptual components of socioeconomic status during operationalization and measurement.

Assessment of Subjective and Objective Socioeconomic Status

While material capital, human capital and social capital were found to be the most predictive of the relationship between socioeconomic status and health outcomes in a pilot study, this method was an attempt to alleviate the overwhelming inconsistencies in addressing the gap between the "SES Measurement" and "SES and Health" domain (Oakes and Rossi, 2003). As such, measures of socioeconomic status such as the Hollingshead Four-Factor Index of Socioeconomic Status and the MacArthur Scale of Subjective Social Status have been the most commonly utilized and are also sufficiently predictive of health outcomes.

The most widely-used subjective socioeconomic status measure in health psychology, the MacArthur Scale of Subjective Social Status, arose out of a desire to capture individual sense of place in the social ladder while taking into account standing on multiple dimensions of socioeconomic status and social position (Adler and Stewart, 2007). This scale was originally derived to address the issue of different indicators of socioeconomic status each showing similar graded relationships with health despite only moderate interrelatedness (Adler and Stewart, 2007). Numerous attempts have since been made to delineate the reliability of the construct being measured, generating good stability in test-retest under certain community contexts (Giatti, Camelo, Rodrigues, & Barreto, 2012).

The scale is presented in an easy pictorial format, representing a "social ladder" and asks individuals to place an "X" on the rung in which they feel they stand (Adler and Stewart, 2007).

Figure 2.1 *The MacArthur Scale of Subjective Social Status (Adler and Steward, 2007). Includes the directive "Now think about your family. Please tell us where you think your family would be on this ladder. Select the rung that best represents where your family would be on this ladder."*

Two different versions of the ladder aim to assess both objective SES indicators and one's standing within a community structure. The difference between the two may be of particular interest in poorer communities in which individuals may not be high on the objective SES ladder in terms of income, occupation or education, but may have high standing within their social groups such as a religious or local community (Zell, Strickhouser, & Krizan, 2018). It is to the individual's discretion to weigh the various components of socioeconomic status and ultimately determine what aspects are most identifying of subjective socioeconomic status.

A popular mode of measuring objective socioeconomic status in health psychology is the Hollingshead Four-Factor Index of Socioeconomic Status which was developed in order to accommodate for the fact that social status is a multidimensional concept according to three premises (Hollingshead, 1975). Firstly, it is acknowledged that a differentiated, unequal status structure exists in our society. Secondly, the primary factors indicative of status are the occupation an individual engages in and the years of

schooling he or she has completed. Other salient factors include sex and marital status. Thirdly, these factors may be combined so that a researcher can quickly, reliably and meaningfully estimate the status positions individuals and members of nuclear families occupy in our society.

Education is often variable throughout childhood and youth, yet it stabilizes in adulthood. The number of years of school an individual engages in tends to reflect the degree of knowledge attained. For many occupations carrying significant social prestige, education is a necessary prerequisite to entry. In early adulthood, one's occupation may undergo alterations, yet it tends to become a stabilized trait in the late twenties and early thirties. Occupation is assumed to indicate an individual's level of skill and power performed in order to maintain the function of society. Sex remains constant, but it plays an important role in individuals' performance of such societal maintenance functions. Lastly, the family system is defined by the marital status of men and women, which may or may not maintain stability from early adulthood into old age (Hollingshead, 1975).

Since the implementation of such a scale, it is evident that the societal structure of both the individual and nuclear family have shifted in terms of all four dimensions such that they no longer may be as precisely predictive as at the point of the scale's origin (Gottfried, 1985). For example, occupation is keyed to the approximate 450 occupational titles and codes of the 1970 United States Census and is graded on a 9-point scale. However, in some occupational categories (proprietors of businesses, military personnel, farmers and persons dependent upon welfare), precise title delineation was considered inadequate by Hollingshead, so some occupations depart from the 1970 Census. The validity and reliability data are derived from the 1970 Census and the National Opinion

Research Council, which deemed it a highly reliable and valid measure of socioeconomic differentiation in the United States at the time (Gottfried, 1985).

In order to alleviate controversies associated with the outdated categorization of some of the scales within present-day society, parents' highest level of occupational status was selected as a measure representative of objective socioeconomic status in the current study. As a questionnaire item similar to the Swedish economic indicator (SEI), the assessment implemented in the current study provided divisions into unskilled laborers, skilled laborers, lower employees, middle/upper level employees and professionals, which provides flexibility, comparability and simplicity (Sundquist and Johansson, 1997). The SEI specifically was designed to capture the complexity of employment status, occupational status and even educational attainment through its categorization. Tables developed by Blishen and colleagues for Canadians allow for the coding of educational and income levels for various occupations, and its U.S. counterpart, Duncan's SES index, is considered to be the most appropriate means of ranking North American societies in terms of social and economic conditions (Demissie, Hanley, Menzies, Joseph, & Ernst, 2000). Therefore, based on the recent literature consensus, the current study considers the MacArthur Scale of Subjective Social Status to be the most accurate indicator of subjective SES and parental occupational status to be the most accurate indicator of objective SES.

Socioeconomic Status and Health

Objective and subjective socioeconomic status are both significantly related to health outcomes, with subjective socioeconomic status serving as a better predictor

(Singh-Manoux, Marmot, & Adler, 2005; Cundiff and Matthews, 2017). This has been supported in previous research.

Table 2.2 *Selected studies on subjective versus objective socioeconomic status operationalization.*

Study	Subjective versus Objective SES
Ghaed & Gallo (2007)	A person's position in the social hierarchy could have important health implications beyond the impact of objective SES
Quon & McGrath (2014)	Subjective SES was associated with health during adolescence, with larger effects observed for mental health outcomes, self-rated health and general health symptoms after controlling for objective SES
Gong, Xu, & Takeuchi (2012)	Objective SES indicators were non-significantly related to self-rated physical health, physical discomfort, self-rated mental health and psychological distress in Asian Americans whereas subjective SES showed strong associations with health outcomes

While it is not necessary to consider every contributing factor of socioeconomic status simultaneously, each predictor may be optimally associated with different health indicators. For example, in aging populations, the relationship between declining health and declining subjective SES tends to be bidirectional (Nobles, Weintraub, & Adler, 2013). However, the stressor-health association appears to be interdependent with objective SES (Gryzwacz, Almeida, Neupert, & Ettner, 2004).

That being said, assessments that attempt to focus on the various components of subjective socioeconomic status have been found to be more predictive of health outcomes than objective assessments of socioeconomic status alone. According to a study conducted by Cundiff and Matthews (2017), subjective SES was found to be a better predictor of health status as well as a more pertinent means to understanding discrepancies in health. Similarly, subjective social status was found to be more

consistently and strongly related to psychological functioning and health related factors including self-rated health, heart rate, sleep latency, body fat distribution and cortisol habituation to repeated stress (Adler, Epel, Castellazzo, & Ickovics, 2000). Prag, Mills and Wittek (2016) also found that after accounting for the effects of subjective SES on health, objective measures made no additional contribution in explaining health. These findings indicate the importance of individually assessing the components of socioeconomic status in order to determine which one is most predictive of health risks.

Objective versus Subjective Socioeconomic Status and Health

The literature also often distinguishes between environmental versus psychological constraints and resources as factors influenced by both objective and subjective SES (Adler and Ostrove, 1999). Both of these categories attempt to differentiate between the various inputs leading to either health or illness (Adler and Ostrove, 1999).

Table 2.3 *Selected studies of differing levels of analysis for socioeconomic status.*

Study	Levels of Analysis
Veenstra (2000)	Individual-level elements of social capital – trust, commitment and identity in a social-psychological dimension; participation in clubs and associations and civic participation in the action dimension – as related to self-rated health status
Steptoe & Feldman (2001)	Residential neighborhood problems constitute sources of chronic stress that may increase risk of poor health
Anderson et al. (1997)	Ecologic-level indicators of SES (e.g., median income of persons living without countries, zip code areas or census tracts) are thought to be useful surrogate measures in the absence of an individual's information

.

For example, it has been proposed that area measures of SES such as deprivation may be more predictive of poor health outcomes than other SES measures such as income, education, poverty level, occupation and wealth, and also more representative of access, use and quality of healthcare (Gornick, 2002).

The relationship between SES and health has been the focus of research particularly within the fields of epidemiological and sociological research for the past three decades (Adler et al., 1994). From these studies it can be concluded that there is a graded relationship between measures of SES and health outcomes and behaviors in most developed countries (Marmot, Kogeyinas, & Elston, 1987). Health behaviors are one important mediator of this relationship but cannot explain the entire SES-health relationship (Adler and Newman, 2002). In addition, the direction of causality also can be bidirectional between SES and health (Deaton, 2002). Empirical evidence from longitudinal data suggests that SES drives much of the observed differences in health (Chandola et al., 2003). Lastly, the social environment is related to individual health through effects that are independent of individual characteristics by conditioning and contextualizing individual responses to threats to health (Yen and Syme, 1999).

Interest in this relationship has resurged and can be attributed to several reasons. First of all, since science is cumulative and established through precedence, the relationship between SES and health has been documented for centuries, dating back to ancient Greece, Egypt and China (Krieger, Williams, & Moss, 1997; Liberatos, Link, & Kelsey, 1998; Lynch, Kaplan, Cohen, Tuomilehto, & Salonen, 1996). Additionally, there is a sufficient supply of funding due to the importance of SES for agencies interested in explaining public health, such as the NIH (Oakes and Rossi, 2002). Due to the declining

prevalence of acute infections, SES is relevant to social policy concerning public health in that it provides the opportunity for medical intervention, epidemiological screening (Taylor, Repetti, & Seeman, 1997) and public policy (Kaplan and Lynch, 2001). Furthermore, due to the rising economic inequality in the US, a greater portion of income and wealth is allocated to fewer upper SES individuals while a corresponding rise in the relative impoverishment of many lower SES individuals raises concerns particularly for racial minorities (Massey and Denton, 1993). Lastly, in the absence of accurate SES information, racial and ethnic disparities in health may be construed as signs of genetic differences or behavioral choices rather than powerful indicators regarding the past and present harms to health posed by racial discrimination and structural constraints (Krieger et al., 1997; Williams, 1996).

More recent research has emphasized the importance of considering the SES-health link as a continuum, with consequences sliding along the spectrum and not just isolated to those with various measures of low SES. A large volume of research on health inequalities has been published, and cardiovascular disease is arguably the condition for which the most evidence of social gradients in incidence and risk exists (Steptoe and Marmot, 2002). However, the majority of available data are derived from high-income countries (Okrainec, Banerjee, & Eisenberg, 2004). In high-income countries, low SES among adults aged 30-59 years is independently associated with a 55% increase in ischemic heart disease mortality risk in men and a greater than twofold risk increase in women (Avendano et al., 2006). Finally, a large number of cohort studies found significant associations, after adjustment for behavioral risk factors, between parental SES and cardiovascular disease risk during adulthood.

Models of Mechanisms Linking Socioeconomic Status to Health

Two competing theories regarding the association between SES and health include the social causation model and the social drift model (Adler and Ostrove, 1999). The social causation model states that SES influences health status measures such as cardiometabolic factors including waist circumference, body mass index, fasting glucose and fasting insulin (Elovainio et al., 2011). The social drift model indicates that health status contributes to socioeconomic status. Support for the social drift model is found for childhood diseases that consist of early onset and profound effects on life trajectories but is generally limited in its feasibility outside of the psychological realm (Adler and Ostrove, 1999; Ploubidis, Benova, Grundy, Laydon, & DeStavola, 2014). However, more collective support has been attained for the social causation model (Adler and Ostrove, 1999). For example, education acquired through young adulthood has been found to correspond to health problems emerging many years later, suggesting that educational attainment is determining later health.

A study conducted with United Kingdom men and women over the course of ten years found that the social drift model operated at younger ages and that the social causation model contributed to socioeconomic differences in cardiometabolic health at midlife (Elovainio, 2011). Importantly, a systematic review of the literature regarding the competing claims of the social causation and social bias theories found that while there was no general preference for either of the hypotheses, studies using SES indicators closely related to the labor market find equal support for both theories, while those using

SES indicators like education and income yield results that favor the social causation hypothesis (Kroger, Pakpahan, & Hoffmann, 2015).

An additional set of dueling theories relating age, SES and health inequality at the population level are the accumulation hypothesis and the divergence-convergence hypothesis (Prus, 2007). The accumulation hypothesis predicts that the level of SES-based health inequality, and consequently, the overall level of health inequality, within a cohort progressively increases as it ages. The divergence-convergence hypothesis predicts that these inequalities increase only up to early-old age then decrease.

A study conducted by Prus (2007) utilizing a Canadian national health survey produced results supporting the accumulation hypothesis, for inequality was found to change steadily, but moderately, up to ages 40-49, and then there was an even greater dispersion in health outcomes especially during old age. Another study conducted by Singh-Manoux, Ferrie, Chandola and Marmot (2004) provided additional support for the accumulation hypothesis in that men with measured low socioeconomic position at three points in the life course had increased chances of coronary heart disease, poor physical functioning and poor mental functioning. Likewise, in women there was an accumulation effect for coronary heart disease and physical functioning.

The hierarchy-health hypothesis states that subjective SES is important due to its mechanisms related to one's place in the social hierarchy, and subjective status reflects a person's "relative" social position as opposed to "absolute" social position (Singh-Manoux, Marmot, & Adler, 2005). The discrepancy between objective and subjective status is related to the notion of relative social position. Hierarchical rank influences health by two mechanisms: direct effects of physiological processes and neuroanatomic

structures, leading to an increase in biological vulnerability to disease; and indirectly through unhealthy behaviors.

Lastly, the averaging hypothesis suggests that subjective SES is both a social and an economic phenomenon and perhaps a better measure of SES at the individual level than any single indicator of SES (Singh-Manoux, Marmot, & Adler, 2005). Recently, a paper used 16 variables categorized into four groups (indicators of objective SES, wealth measures, life satisfaction measures and measures of psychological functioning) to predict subjective SES. This study concluded that subjective SES represents a cognitive average of standard markers of SES, including elements representing an assessment of current and future prospects.

Out of all the models, the social causation model is by far the most supported and accepted with regards to explaining the link between socioeconomic status and health. As such, the current study will focus primarily on examining the mechanisms posed by the social causation model, particularly the relationship between objective and subjective measures of SES and health outcomes related to cardiovascular functioning.

Cardiovascular Reactivity to Psychological Stress

The reactivity hypothesis proposes that prolonged or exaggerated cardiovascular reactivity to psychological stress can cause structural and functional changes in the heart that promote the development of cardiovascular disease (Obrist, 1981). This is contrary to what is observed in physical exercise, in which cardiovascular adjustments are deemed healthy. The difference between a healthy and unhealthy cardiovascular response may be best determined by whether or not it is metabolically appropriate (Carroll, Phillips, & Balanos, 2009). In the case of exercise, increases in cardiovascular activity are equally

matched by an increase in metabolic energy to meet the demands of muscle exertion. Therefore, the two systems are functioning in a coordinated manner. However, during psychological stress, the cardiovascular response is often far greater than the metabolic demands, and the heart is working disproportionately harder in comparison to the rest of the body (Obrist, 1981).

Numerous studies have demonstrated cardiovascular responses to laboratory psychological stress tasks to be exaggerated in comparison to the expected physical energy requirement (e.g., Balanos et al., 2010; Carroll, Phillips, & Balanos, 2009; Carroll, Ginty, Der, Hunt, Benzeval, & Phillips, 2012). Other studies replicate these findings outside of the laboratory setting. Warwick-Evans, Walker and Evans (1988) found that female cardiovascular reactivity was comparable between a laboratory session involving relaxation as well as cold pressor and mental arithmetic tasks and exercise and academic examination. Similarly, Matthews, Manuck and Saab (1986) observed exaggerated increases in cardiovascular measures while performing laboratory stress tasks as well as a naturally occurring stressor, a required five-minute speech in a high school English class, among adolescents. Lastly, exaggerated levels of blood pressure and heart rate were measured during a mental arithmetic task as well as in the work setting (Fredrikson et al., 1989). More recent evidence suggests that individual differences in cardiovascular responses to a laboratory stress task are associated with individual differences in responses to stress in a natural setting, however, responses in a natural setting may elicit higher overall responses (Zanstra and Johnston, 2011).

Further research supports that these exaggerated cardiovascular responses to psychological stress are predictive of poor cardiovascular outcomes such as coronary

heart disease (for reviews see Heslop, Smith, Carroll, Macleod, Hyland, & Hart, 2001; Fiscella and Tancredi, 2008; Schultz et al., 2018), carotid atherosclerosis (Lynch, Everson, Kaplan, Salonen, & Salonen, 1998), hypertension (Carroll, Ring, Hunt, Ford, & Macintyre, 2003; Spruill, 2010; Merritt, Bennett, Williams, Sollers, & Thayer, 2004; Chida and Steptoe, 2010), acute myocardial infarction (Lynch, Krause, Kaplan, Tuomilehto, & Salonen, 1997) and all-cause mortality (Lynch, Kaplan, Cohen, Tuomilehto, & Salonen, 1997; Steenland, Hu, & Walker, 2004; Lazzarino, Hamer, Stamatakis, & Steptoe, 2013). These findings not only support the reactivity hypothesis, but suggest that a dichotomous relationship could exist: blunted cardiovascular responses to psychological stress may be beneficial for health (Carroll et al., 2017). However, recent research has suggested that blunted cardiovascular responses to psychological stress may also lead to adverse health and behavioral outcomes (Carroll, Phillips, & Lovallo, 2012). It appears that departures from the norm of physiological responding in either direction may pose problems because the cardiovascular system is operating in a biased state (Carroll et al., 2009). This can be conceptualized as an inverted-U model where high and low reactivity are bad for health depending on the health outcome in question.

The precursors of poor cardiovascular disease outcomes have been cited as associated with blunted cardiovascular reactivity to psychological stress. According to Carroll et al. (2017), blunted cardiovascular reactions to acute psychological stress are associated with adverse behavioral and health outcomes including depression, obesity, bulimia and addictions which may reflect suboptimal functioning of the brain's fronto-limbic systems that are needed to regulate motivated behavior in the face of challenge.

Despite the longstanding body of research supporting the reactivity hypothesis, the current study hypothesizes blunted cardiovascular reactivity to acute psychological stress due to the emerging current studies supporting a nuanced relationship.

Subjective versus Objective Socioeconomic Status and Cardiovascular Reactivity

Disruption of homeostasis within the body has been proposed as a mechanism by which exaggerated cardiovascular reactivity to psychological stress relates to disease. In order for proper functioning of the body to occur, homeostasis is a necessary state. Homeostasis is defined as a self-regulating process by which biological systems maintain stability while adjusting to changing conditions (Billman, 2012). Effectively, the body attempts to respond to both internal and external stimuli in such a way that internal functioning is maintained. Exaggerated cardiovascular reactivity disrupts this balance via both cognitive-emotional and hypothalamic-brainstem sources which may cause or aggravate disease in the presence of psychological stressors (Lovallo and Gerin, 2003). However, under certain circumstances, it is essential for the body to briefly fall out of a state of homeostasis in order to appropriately respond to significant stimuli. Increased cardiovascular functioning in response to stressful life events may be evolutionarily adaptive, for temporarily arousing the body enables one to confront or escape external threats (Boyce and Ellis, 2005).

It is necessary to examine the means by which physiological responses to stress are altered across subsequent exposures. The two mechanisms of response to repeatedly presented stimuli are habituation and sensitization (Kelsey, Soderlund, & Arthur, 2004). According to theories pertaining to habituation, it is regarded as inhibition of automatic responses to expected and repeated stressful stimuli. On the contrary, sensitization is

marked by arousal or activation in response to novel, significant or intense stressful stimuli. These patterns of adaptation over time may be important for further understanding the relationship between cardiovascular reactivity and later-life disease.

Psychobiological processes can be defined as the pathways through which psychosocial factors stimulate biological systems via central nervous system activation of automatic, neuroendocrine and immunological responses (Steptoe, 1998). In order to generate the gradient that links SES with cardiovascular health to understand habituation and sensitization in this context, it is necessary to consider various potential contributing components. Although coronary heart disease has a strong hereditary component, it is evident that this may be due to variations in gene expression that result from differential psychosocial or physical exposures. Adult behavioral and psychosocial risk factors including smoking, physical inactivity, hostility, job strain and poor psychological well-being are considered to be determinant upon societal position early in life. The majority of diseases relating directly to poverty involve infections or exposures to hazards associated with poor water supplies, unhygienic living conditions and industrial pollution. Furthermore, upon analyzing 'avoidable' hospitalizations for conditions such as malignant hypertension, lower income groups in the US demonstrated higher rates of hospitalization, perhaps reflecting poorer quality primary health care. Altogether, the socioeconomic gradient for behaviors related to cardiovascular disease, such as cigarette smoking, alcohol consumption, physical activity and nutrition, are prominent in many countries (Steptoe and Marmot, 2002).

There is a body of literature pertaining to lower SES individuals experiencing repeated exposure to stressors related to poverty, which may further explain patterns of

habituation or sensitization in cardiovascular responses. For example, Evans and Kim (2007) found that the greater the number of years spent living in poverty, the more dysregulated the cardiovascular response (i.e., blunted reactivity). Consequently, the effects of childhood poverty on stress dysregulation are largely explained by cumulative risk exposure accompanying childhood poverty.

Lastly, the most recent and influential meta-analysis pertaining to the subject specifically of SES and cardiovascular health aimed to identify underlying biological mechanisms via plausible physiological processes that are sensitive to the environmental and psychosocial contexts that vary across socioeconomic strata and play a role in disease pathology (Boylan, Cundiff, & Matthews, 2018). The proposed biological pathways include the autonomic nervous system, the hypothalamic-pituitary-adrenal axis and the immune system. These systems engage coordinated physiological responses in order to prepare the body to respond to acute physical stressors by mobilizing energy and directing important resources, like oxygen and glucose, to the brain and muscles. However, repeated or prolonged activation of this stress response system, which can also be invoked via psychological stressors, has detrimental effects on the body physiologically. The results of this study indicated that SES was not associated with cardiovascular stress reactivity when examining all types of stress tasks. Sub-analyses in the meta-analysis suggest that when the acute psychological stress task is cognitive in nature (e.g., mental arithmetic task) that higher SES is associated with higher reactivity (Boylan, Cundiff, & Matthews, 2018). However, the meta-analysis only examined objective measures of SES and did not include subjective measures of SES. Suggestions

for future research include investigating how both cardiovascular reactivity and recovery from stress may be linked with SES and poor health outcomes.

Study Hypotheses

Based on previous research (e.g., Singh-Manoux, Marmot, & Adler, 2005; Phillips, Ginty, & Hughes, 2013), it was hypothesized that higher subjective socioeconomic status would be associated with an increase in cardiovascular reactivity. It was hypothesized that higher objective socioeconomic status would produce non-significant differences in cardiovascular reactivity (Abel, Epel, Castellazzo, & Ickovics, 2000).

CHAPTER THREE

Methods and Results

Study 1

Aims and Hypotheses

The aim of study 1 was to examine the association between subjective socioeconomic status and heart rate reactivity as well as blood pressure changes in response to an acute psychological stress task. It was hypothesized that greater heart rate reactivity and blood pressure changes resulting from exposure to a stress task would be associated with higher subjective socioeconomic status.

Methods

Participants. Participants included 88 healthy individuals who had no current illness or infection and no history of cardiovascular disease. Participants were asked to abstain from alcohol for the 12 hours prior to the study, vigorous exercise for the 12 hours prior to the study, and food and caffeine for the 2 hours prior to the study. There were 67.9% females and 51.7% Caucasian participants. The age range was from 18 to 62 years (*M* [SD] age = 26.9 [10.7] years). All participants provided written informed consent and were compensated financially with payment cards for their time in the lab. The study was approved by the Baylor University Institutional Review Board and data was collected from June 2018 to August 2018.

Cardiovascular measures. Blood pressure and heart rate readings were conducted via a GE Carescape V100 every 2 minutes throughout the 10-minute baseline period and 10-minute stress task via cuff attached to the participant's non-dominant arm. Participants were instructed to remain still and quiet throughout the baseline period with their feet uncrossed and to minimize movements throughout the stress task.

Questionnaires

Subjective socioeconomic status. The MacArthur Scale of Subjective Social Status (Adler and Steward, 2007) assessed common conceptions of socioeconomic indicators in order to provide a sense of social status. It is observed that social hierarchies arise from a variety of different indicators predictive of health, such as education, income and occupation. The purpose of the MacArthur Scale of Subjective Social Status is to indicate an individual's sense of their place in the social ladder, considering multiple dimensions of socioeconomic status and social position. In an easy-to-understand illustration, participants were presented with a simple ladder described as a social hierarchy, ranking from the lowest rungs to the highest. The lowest rung on the ladder receives a rank of 1 and is labeled as "worst off", whereas the highest rung on the ladder receives a rank of 10 and is labeled as "best off". The rungs increase by increments of one. Participants are asked to place an "X" on the rung in which they feel their family stands. The question stem states: "Imagine that this ladder shows how your society is set up. At the top of the ladder are the people who are the best off – they have the most money, the highest amount of schooling and the jobs that bring the most respect. At the bottom are people who are the worst off – they have the least money, little or no education and no jobs or jobs that no one wants or respects" (Adler and Steward, 2007).

Figure 3.1 *The MacArthur Scale of Subjective Social Status (Adler and Steward, 2007). Includes the directive "Now think about your family. Please tell us where you think your family would be on this ladder. Select the rung that best represents where your family would be on this ladder."*

Acute Stress Tasks

Mental arithmetic stress. Participants completed a 10-minute version of the Paced Auditory Serial Addition Test (PASAT; Gronwall, 1977) whereby a series of single-digit numbers were presented through an audio speaker. Participants are instructed to add consecutive numbers together, verbalize their response and simultaneously remember the most recently read number in order to add it to the following read number. While the PASAT was originally developed in order to assess cognitive functioning, research by Veldhuijzen van Zanten, Ring, Burns, Edwards, Drayson, and Carroll (2004) has indicated its effectiveness in arousing a stress response. Due to its high levels of internal consistency and test-retest reliability, its original intent as a cognitive diagnostic tool has been translated into broader use as a stress-inducing method (Ginty, Gianaros, Derbyshire, Phillips, & Carroll, 2013). Participants were played a series of standard instructions via an MP3 player prior to conducting the test and were allowed a practice period in order to ensure adequate understanding. The PASAT was then played as a standardized recording and participants provided answers aloud along with added

stressors present. These included a video camera, mirror, buzzer for "incorrect answers", and comparison table ranking other participants' scores. The experimenter stated that the video camera was taping the participant in order to analyze body movements, although during the debriefing it was indicated that the video camera was not actually recording. The participant was instructed to face the mirror and maintain eye contact throughout the duration of the 10-minute test. Lastly, the instructions stated that the buzzer was to be used in response to any incorrect answers, skipped questions, stuttering, mumbling, or hesitation in completing the task. However, the buzzer was sounded one time during recurring shaded boxes on the scoring sheet, independent of how the participant responded or reacted. These added stressors were to ensure an evoked physiological stress response as measured by cardiovascular means. Finally, throughout the duration of the PASAT, an experimenter in a white lab coat stood over the participant and scored their performance in an attempt to evoke additional stress.

Procedures

Following informed consent, the individual was instructed to sit in the testing room while a blood pressure equipment was placed on their non-dominant arm. The participant then underwent a practice blood pressure reading to ensure it was reading properly and felt comfortable. Afterwards, a 10-minute baseline period was provided whereby the participant was instructed to remain still and quiet while they got adapted to the room. Meanwhile, blood pressure readings were collected every two minutes. Following the baseline period, participants listened to a set of standardized instructions explaining the stress task. They were then allowed the opportunity to practice the PASAT to ensure they understood how to complete it. Next, more standardized instructions were

provided that listed the additional stressors. Upon their mention, the researcher pointed out the comparison table hanging on the wall, turned the video camera and opened it to the on position, placed the mirror directly in front of the participant and sounded the buzzer as an example. After completion of the instructions and room setup, the participant engaged in the 10-minute PASAT whereby blood pressure was assessed every two minutes and a researcher scored the task according to their responses. Following the stress task, the participant completed a survey which contained the MacArthur Scale of Subjective Social Status and other demographic information. Lastly, the participant was debriefed regarding the experimental stress manipulations and provided a resource sheet listing both local and online mental health resources.

Data Analyses

The present experiment: (1) assessed participants' subjective socioeconomic status through use of the MacArthur Scale of Subjective Social Status, (2) collected baseline measures of blood pressure data and (3) continued to monitor this measure throughout a stress task as evoked by the PASAT in order to analyze the relationship between subjective socioeconomic status and cardiovascular reactivity to stress. Heart rate measurements taken every 2 minutes throughout the baseline period were averaged to yield a pre-task baseline value, and heart rate measurements taken every 2 minutes via the blood pressure readings throughout the mental arithmetic stress task were averaged to produce a PASAT value. Subsequently, reactivity for heart rate was computed by subtracting the mean baseline from the mean PASAT value. An analysis of variance (ANOVA) was utilized in order to ensure a difference between the baseline and stress assessments of cardiovascular measures. A correlation analysis determined lower

subjective socioeconomic status as a significant predictor of blunted cardiovascular reactivity, as suggested by previous findings. All data was analyzed in SPSS (version 22) (Trotman, Gianaros, Veldhuijzen van Zanten, Williams, & Ginty, 2019). Therefore, a sample of 88 participants was analyzed. The alpha level was designated as $p < 0.05$ for all analyses.

Results

Heart rate. The acute psychological stress task significantly perturbed heart rate, $F(1, 86) = 104.67$, $p < .001$, $_{p}eta^2 = .549$. Heart rate was higher during stress compared to baseline.

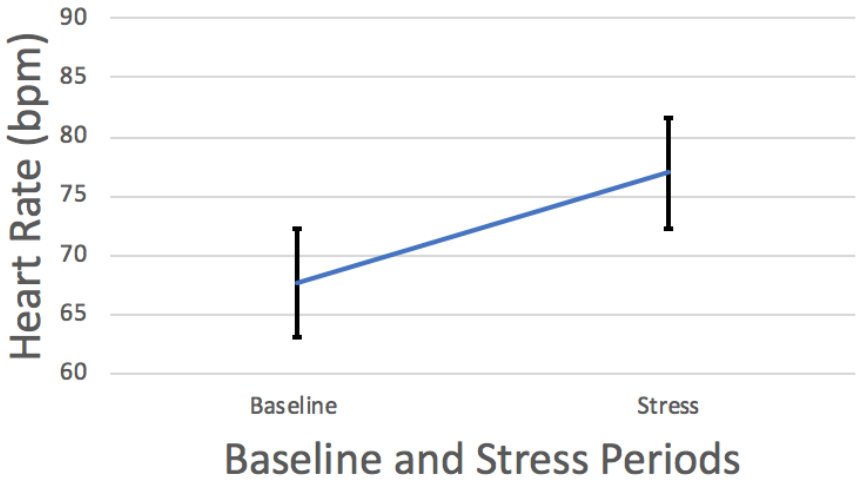

Figure 3.2 *Heart rate (measure in bpm) activity during baseline compared to during the acute psychological stress task.*

Systolic blood pressure. The acute psychological stress task significantly perturbed systolic blood pressure, F (1, 86) = 186.86, $p < .001$, $_{p}eta^{2} = .685$. Systolic blood pressure was higher during stress compared to baseline.

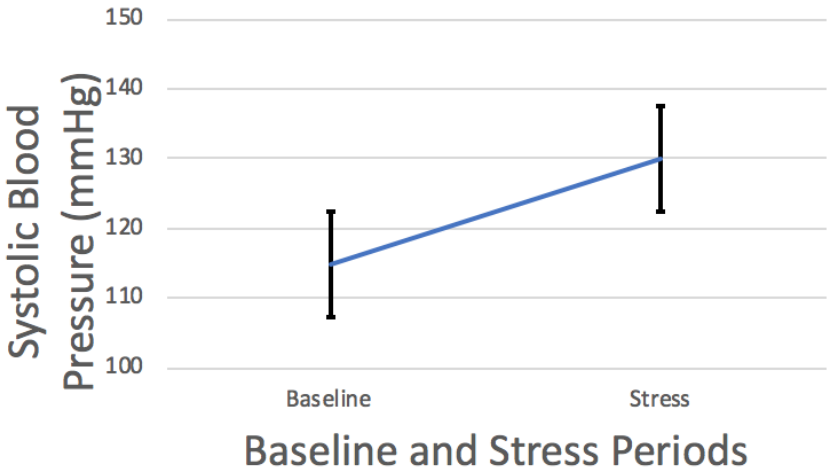

Figure 3.3 *Systolic blood pressure (measured in mmHg) activity during baseline compared to during the acute psychological stress task.*

Association between heart rate reactivity and subjective socioeconomic status. A statistically significant positive correlation existed between subjective socioeconomic status and heart rate reactivity ($r = .29$, $p = .007$), indicating individuals with lower subjective socioeconomic status had decreased heart rate reactivity between the baseline and PASAT.

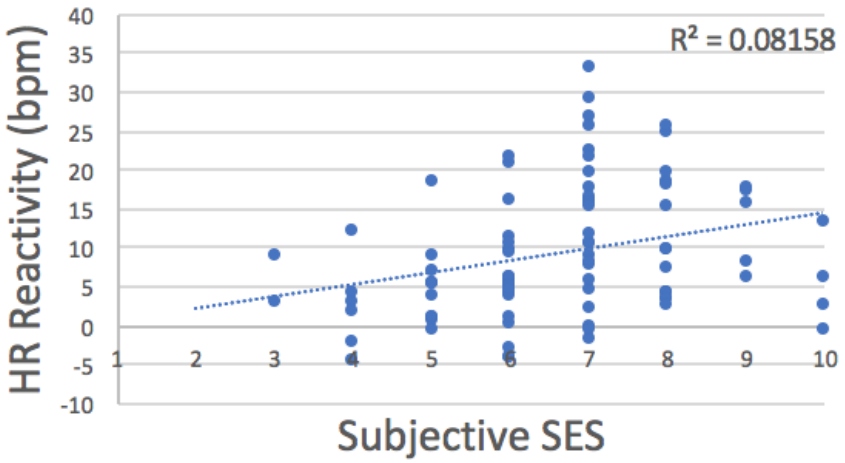

Figure 3.4 *Heart rate reactivity (measured in beats per minute) versus subjective socioeconomic status.*

Association between systolic blood pressure reactivity and subjective socioeconomic status. A statistically significant positive correlation existed between subjective socioeconomic status and systolic blood pressure reactivity ($r = .24$, $p = .027$), indicating that individuals with lower subjective socioeconomic status had decreased systolic blood pressure reactivity between the baseline and PASAT.

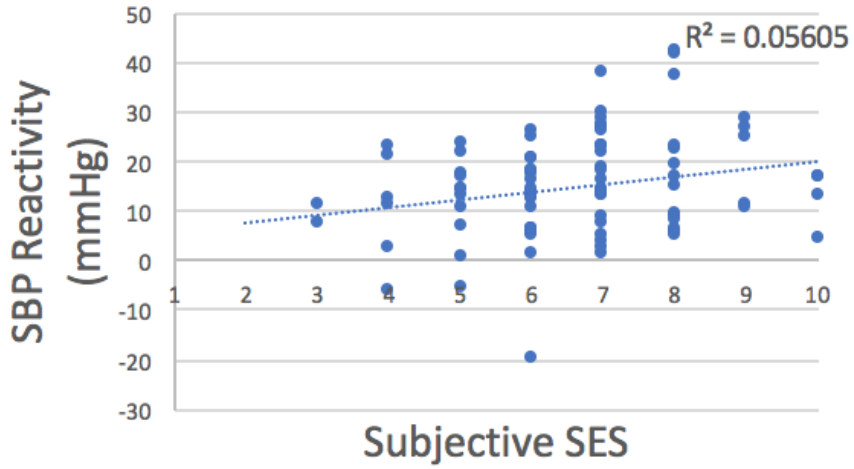

Figure 3.5 *Systolic blood pressure reactivity (measured in mmHg) versus subjective socioeconomic status.*

Summary of Study 1 Findings

Lower levels of subjective socioeconomic status were associated with blunted cardiovascular responses, as indicated by both significantly lower heart rate reactivity and systolic blood pressure. As hypothesized, blunted heart rate reactivity and blood pressure changes resulting from exposure to a stress task were associated with lower subjective socioeconomic status and vice-versa with higher subjective socioeconomic status.

A limitation of study 1 is that traditional measures of socioeconomic status, such as parents' income, occupation and education statuses, were not included in the questionnaire materials. Since the age range of participants was widespread due to recruitment among community members, it is possible that aspects of heart rate and blood pressure reactivity may be contributable to the diversity of the sample. Furthermore, the compensation component may have attracted a particular participant type that would pose a confound with the measured subjective socioeconomic status. Further investigation as to how subjective socioeconomic status relates to objective socioeconomic status is needed in order to clarify which measure may be ultimately more important for health outcomes. Therefore, Study 2 addressed these limitations primarily by including the traditional socioeconomic status indicator of parents' occupational status. This study aimed to extend the findings to compare subjective socioeconomic status with that of traditional measures.

Study 2

Aims and Hypotheses

Study 2 aimed to extend the findings of Study 1 by investigating the effect that objective socioeconomic status, measured by parents' occupational status, had in relating the variables of cardiovascular reactivity to stress and subjective socioeconomic status. It was hypothesized that there would be no significant difference between heart rate reactivity and blood pressure changes resulting from exposure to a stress task in those with higher objective socioeconomic status versus lower objective socioeconomic status.

Methods Participants.

Participants included 123 healthy individuals. All participant exclusion criteria were identical to study 1. There were 66.7% females and 62.6% Caucasian participants. The age range was from 18 to 23 years (*M* [SD] age = 19.1[0.850] years). All participants provided written informed consent and received an undergraduate research credit. The study was approved by the Baylor University Institutional Review Board and data was collected from January 2019 to May 2019.

Cardiovascular measures. The measures were identical to those of study 1.

Questionnaires

All questionnaires were identical to study 1, aside from a single item addition assessing parents' occupation status. The possible responses for this questionnaire component included: Professional (e.g., doctor/lawyer/PA); Skilled managerial/Technical

craftsman; Skilled non-manual (e.g., nurse/driver); Skilled manual (e.g., craftsman); Partly-skilled (e.g., bus driver/laborer); Unskilled; Armed Forces.

How would you best describe your parent's occupational status? Please use the parent who is the main breadwinner. If parents are not living together, put occupation of parent who has highest occupational status.
Professional (e.g., doctor/lawyer/PA)
Skilled managerial/Technical craftsman
Skilled non-manual (e.g., nurse/driver)
Skilled manual (e.g., craftsman)
Partly-skilled (e.g., bus driver/laborer)
Unskilled
Armed Forces

Figure 3.6 *Survey item regarding highest parental occupational status.*

Acute Stress Tasks

Participants completed a 4-minute version of the 10-minute PASAT used in Study 1.

Procedures and Data Analyses

The procedures and data analyses were identical to Study 1, with the exception that rather than a 10-minute PASAT, a 4-minute PASAT was administered and highest parental occupational status was added as a survey item in order to assess objective socioeconomic status. Missing data due to cardiovascular equipment malfunction ($n = 6$) is reflected by differing degrees of freedom in the respective analyses. An outlier was removed from all analysis that 2 standard deviations below the mean. Therefore, a sample of 115 participants was assessed.

Results

Heart rate at baseline and during acute psychological stress. The acute psychological stress task significantly perturbed heart rate, F (1, 114) = 158, $p < .001$, $_{p}eta^{2} = .59$. Heart rate was higher during stress compared to baseline.

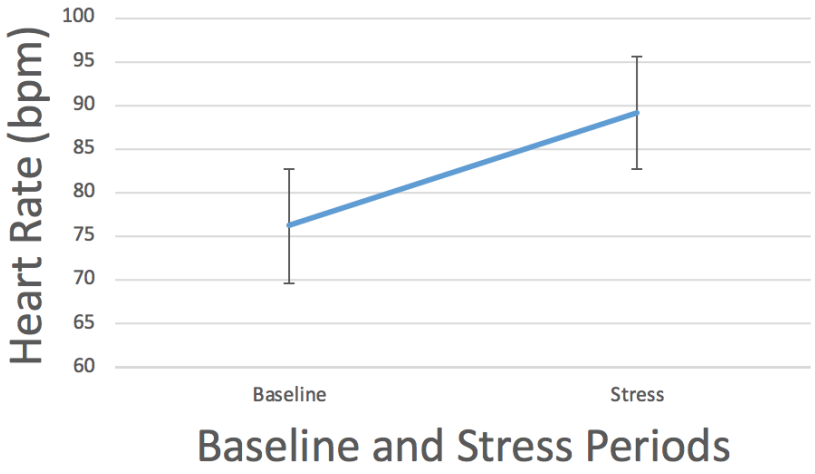

Figure 3.7 *Heart rate (measure in bpm) activity during baseline compared to during the acute psychological stress task.*

Systolic blood pressure at baseline and during acute psychological stress. The acute psychological stress task significantly perturbed systolic blood pressure, F (1, 114) = 465, $p < .001$, $_{p}eta^{2} = .802$. Systolic blood pressure was higher during stress compared to baseline.

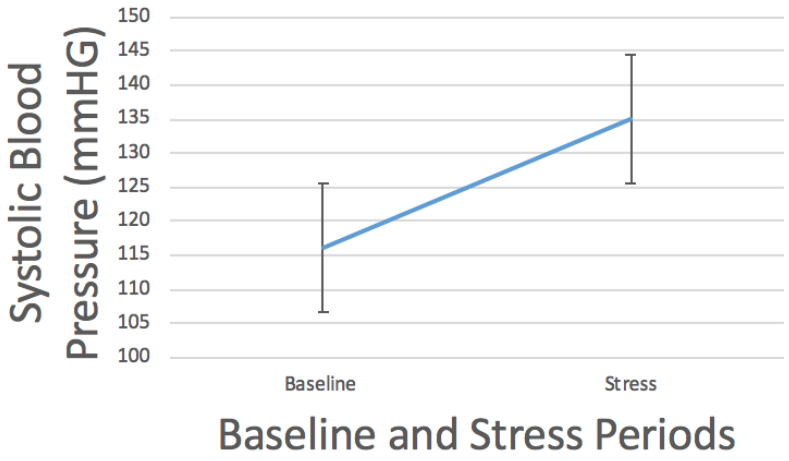

Figure 3.8 *Systolic blood pressure reactivity (measured in mmHg) versus baseline and stress assessments.*

Association between objective and subjective socioeconomic status. A statistically significant positive correlation existed between objective and subjective socioeconomic status ($r = 0.48$, $p < .001$), indicating that individuals with lower objective socioeconomic status tend to have lower subjective socioeconomic status. However, r value indicates that the variables, while related, are independent of one another.

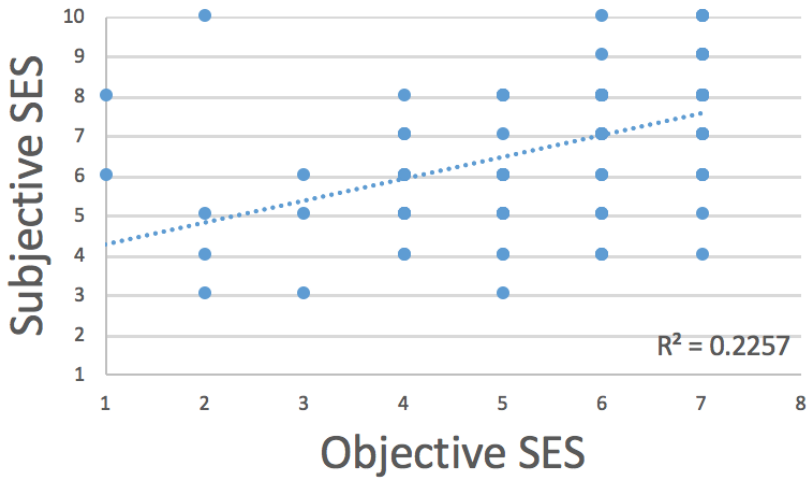

Figure 3.9 *Subjective socioeconomic status versus objective socioeconomic status.*

Association between heart rate reactivity and objective socioeconomic status. A statistically significant negative correlation existed between objective socioeconomic status and heart rate reactivity (r = -0.26, p = .004), indicating individuals with lower objective socioeconomic status had increased heart rate reactivity between the baseline and PASAT.

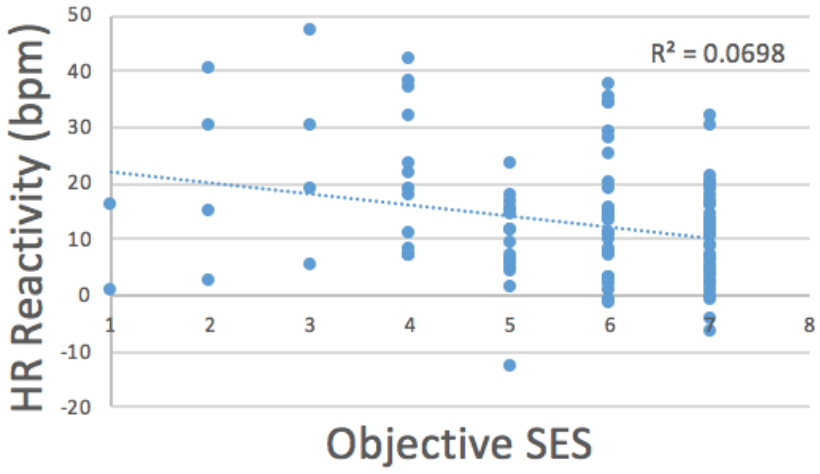

Figure 3.10 *Heart rate reactivity (measured in beats per minute) versus objective socioeconomic status.*

Association between systolic blood pressure reactivity and objective socioeconomic status. A statistically significant negative correlation existed between objective socioeconomic status and systolic blood pressure reactivity (r = -0.22, p = .020), indicating individuals with lower objective socioeconomic status had increased systolic blood pressure reactivity between the baseline and PASAT.

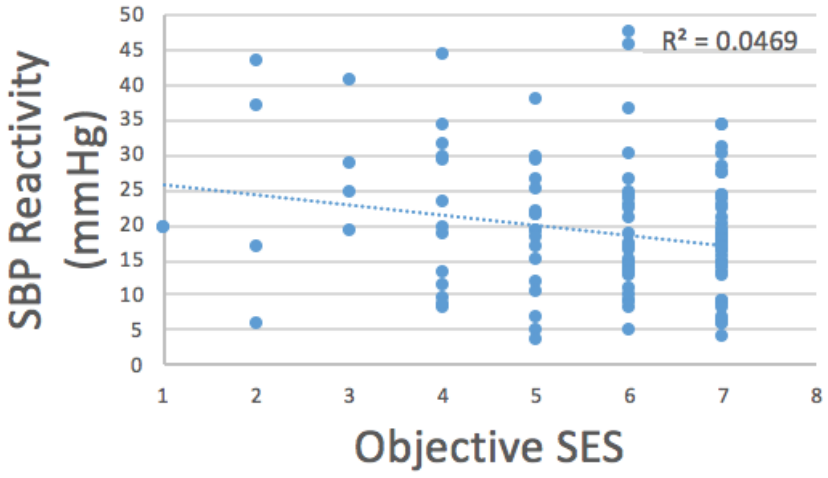

Figure 3.11 *Systolic blood pressure reactivity (measured in mmHg) versus objective socioeconomic status.*

Association between heart rate reactivity and subjective socioeconomic status. No statistically significant correlation existed between subjective socioeconomic status and heart rate reactivity (r = -0.11, p = .250), indicating that individuals with lower subjective socioeconomic did not necessarily have higher heart rate reactivity between the baseline and PASAT.

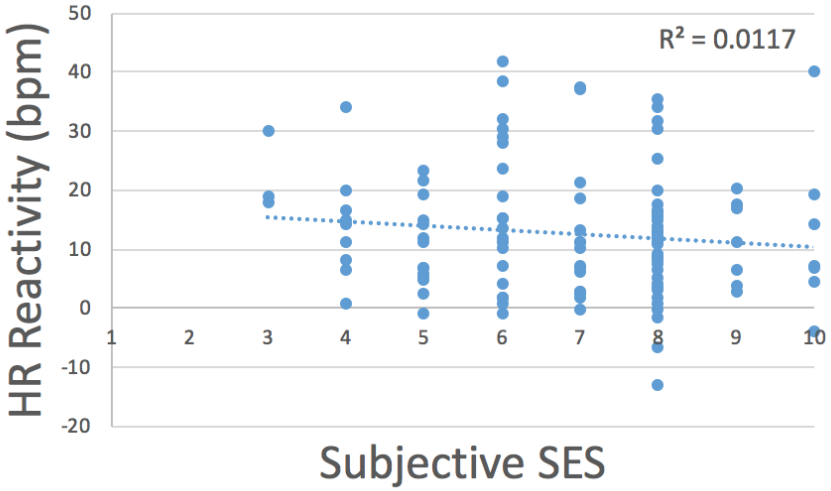

Figure 3.12 *Heart rate reactivity (measured in beats per minute) versus subjective socioeconomic status.*

Association between systolic blood pressure reactivity and subjective socioeconomic status. No statistically significant correlation existed between subjective socioeconomic status and systolic blood pressure reactivity (r = -0.06, p = .551), indicating that individuals with lower subjective socioeconomic status did not necessarily have increased systolic blood pressure reactivity between the baseline and PASAT.

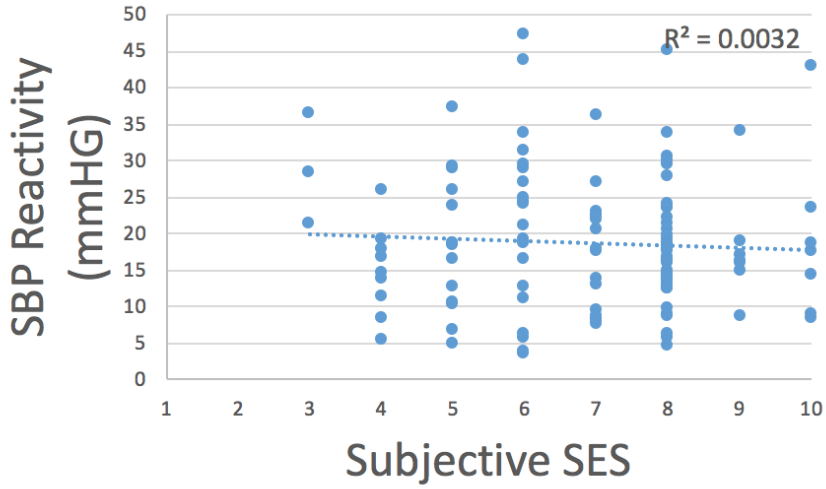

Figure 3.13 *Systolic blood pressure reactivity (measured in mmHg) versus subjective socioeconomic status.*

Summary of Study 2 Findings

In contrast to Study 1, Study 2 found a non-statistically significant negative correlation among heart rate and blood pressure reactivity and subjective socioeconomic status. Contrary to the hypothesis, higher systolic blood pressure reactivity resulting from exposure to a stress task was correlated with lower objective socioeconomic status. Therefore, individuals whose parents' occupational status was lower experienced significantly higher systolic blood pressure reactivity. The primary limitations of Study 2 include the sample age and recruitment method. The vast majority of participants were concentrated as university students receiving a research credit for a course. Therefore, compared to Study 1, the sample was less diverse in terms of age. Addressing the concern in Study 1 pertaining to the directionality of blunted or exaggerated cardiovascular reactivity indicators, it did not support the latter case due to the lack of statistical significance for the negative correlation concerning both heart rate and systolic blood

pressure reactivity and subjective socioeconomic status. While neither Study 1 nor Study 2 were able to explain this relationship for both subjective and objective means of measuring socioeconomic status, each contributed to the body of literature relating both measures to blunted or exaggerated cardiovascular responses. The different results between the two studies suggests that various aspects of the samples may have had an effect, such as age and community member or university student.

CHAPTER FOUR

Discussion

Significance of Findings

The present two study thesis examined the relationship between both subjective and objective socioeconomic status and heart rate reactivity as well as blood pressure changes in response to an acute psychological stress task. Study 1 was conducted in a community sample, and Study 2 was conducted in an undergraduate sample. The directionality of the relationship was such that lower levels of subjective socioeconomic status were related to blunted cardiovascular responses, as indicated by both significantly lower heart rate reactivity and systolic blood pressure in Study 1. In contrast, Study 2 found a non-statistically significant negative correlation among heart rate and systolic blood pressure reactivity and subjective socioeconomic status. Higher systolic blood pressure and heart rate reactivity were correlated with lower objective socioeconomic status. To reiterate, no significant relationship was found between subjective SES and cardiovascular reactivity in Study 2.

Importance of Outcomes

The outcomes of the current study reveal the importance of operationalizing subjective and objective means of both defining and measuring socioeconomic status in order to study its relationship to cardiovascular responses to acute psychological stress. It has been suggested that various facets of socioeconomic status can serve as predictors for different health indicators (Braveman and Cubbin, 2003). For example, subjective social

status was found to be more consistently and strongly related to psychological functioning and health-related factors (Adler, Epel, Castellazzo, & Ickovics, 2000), whereas after accounting for the effects of subjective SES on health, objective indicators made no additional contribution to explaining health (Ostrove, Adler, Kuppermann, & Washington, 2000). As such, each component of socioeconomic status may be predictive of different disease outcomes and should be examined individually. While some research has indicated that the stressor-health association appears to be interdependent with objective SES (Gryzwacz, Almeida, Neupert, & Ettner, 2004), the majority of previous research has specifically demonstrated a relationship between subjective socioeconomic status and increased risk of cardiovascular disease (e.g., Steptoe and Marmot, 2002; Boylan, Cundiff, & Matthews, 2018).

Analysis of First Hypothesis

The statistically significant positive relationships found between subjective socioeconomic status and both heart rate and systolic blood pressure reactivity in Study 1 do not support the original reactivity hypothesis, which stated that higher reactivity is associated with an increased risk of cardiovascular disease. Additionally, these results contradict the previously long-withstanding research support for the reactivity hypothesis (for review see: Phillips and Hughes, 2011). However, the current findings are in accordance with a study examining departures from normal physiological responses in either direction negatively affecting health outcomes related to cardiovascular reactivity (Carroll et al., 2009). This relationship may indicate that blunted cardiovascular responses to acute psychological stress is related to adverse behavioral and health outcomes through biological pathways involving the autonomic nervous system, the

hypothalamic-pituitary-adrenal axis and the immune system (Boylan, Cundiff, & Matthews, 2018).

It has been proposed that lower SES individuals experiencing repeated exposure to stressors related to poverty may experience dysregulated patterns of habituation or sensitization in cardiovascular responses (Evans and Kim, 2007). Interestingly, there is a gradient relationship between measures of SES and both health outcomes and behaviors (Marmot, Kogeyinas, & Elston, 1987), yet with the majority of available data derived from high-income countries (Okrainec, Banerjee, & Eisenberg, 2004), researchers must use caution in interpreting cardiovascular disease as the condition for which the most evidence of a socioeconomic continuum in incidence and risk exists (Steptoe and Marmot, 2002). It is possible that while health behaviors are one important mediator of the SES-health relationship, they cannot explain all variability (Adler and Newman, 2002). Competing theories also have difficulty distinguishing the directionality of this relationship (Deaton, 2002) including the social causation and social drift models among others (Adler and Ostrove, 1999). Additionally, it has been proposed that an initially exaggerated cardiovascular response to a significant stimulus outside of a homeostatic range may be evolutionarily adaptive in order to arouse the body to confront or escape external threats (Boyce and Ellis, 2005). Individuals with lower socioeconomic status reveal less of this beneficial response and rather revert to stress dysregulation in the form of blunted reactivity as largely explained by the cumulative risks posed by childhood poverty (Evans and Kim, 2007). Future research should aim to examine the relationship between long-term poverty and short-term cardiovascular reactivity to immediate stressors compared to the enduring hardships of day-to-day living.

Analysis of Second Hypothesis

The findings in Study 2 indicated that lower objective SES was related to higher cardiovascular reactivity, supporting the adverse health outcomes posed by the reactivity hypothesis. The relationship between subjective SES and cardiovascular reactivity was not statistically significant. This is consistent with other studies examining SES indicators like employment status in support of the social causation hypothesis (Petter, 2008) as well as first occupation as a determinant of later health (Fletcher, 2011). According to the reactivity hypothesis, prolonged or exaggerated cardiovascular reactivity to psychological stress can promote the development of cardiovascular disease due to structural and functional changes in the heart (Obrist, 1981), yet the difference between healthy and unhealthy cardiovascular responses is determinant upon metabolic demands (Carroll, Phillips, & Balanos, 2009). The results of the current study add support to the reactivity hypothesis, such that both laboratory and real-life psychological stress tasks tend to implicate exaggerated cardiovascular reactivity in comparison to the expected physical energy required (e.g., Balanos et al., 2010; Carroll, Phillips, & Balanos, 2009; Ginty, Kraynak, Fisher, & Gianaros, 2017) and thus such a reactionary pattern is implicative of poor cardiovascular outcomes including all-cause mortality (Carroll, Ginty, Der, Hunt, Benzeval, & Phillips, 2012). Contrary to the results relating subjective SES and cardiovascular reactivity in Study 1, Study 2 appeared to dismiss blunted reactivity as the link between lower subjective SES and adverse health outcomes. However, this apparent contradiction was not statistically significant, perhaps suggesting that the reactivity versus blunted hypotheses are both applicable dependent upon the means of assessing

socioeconomic status. It is plausible that the lack of statistical significance pertaining to the positive correlation relating subjective SES and cardiovascular reactivity may reflect important differences between the samples in Study 1 versus Study 2.

Relevance to Existing Body of Literature

The results of the present study are at odds with a previous meta-analysis examining the relationship between socioeconomic status and cardiovascular reactivity (Boylan, Cundiff, & Matthews, 2018). This previous meta-analysis demonstrated that there was no overall association between SES and cardiovascular reactivity to stress. The Boylan, Cundiff and Matthews (2018) meta-analysis suggested that higher SES is related to lower reactivity to tasks with a combination of cognitive, interpersonal and physical challengers. The methodology utilized in the present study induced a cognitive stressor through the performance of the PASAT (e.g., mental arithmetic task) as well as interpersonal stressors through means such as awareness of videotaping, evaluation of nonverbal behaviors, presence of experimenter scoring and display of peer performance tables. Since the measures of SES utilized in the meta-analysis were a variety of objective means (i.e., Hollingshead Four-Factor Index, parental occupation, education, neighborhood SES, etc.), the results were only applicable to Study 2. The negative correlation between objective SES and cardiovascular reactivity found in Study 2 were not supported by the positive correlation between these two measures indicated by Boylan, Cundiff and Matthews (2018). When examining the relationship between socioeconomic status and physiological stress responses, researchers have emphasized the need to differentiate between laboratory and real-life stressors. In these two scenarios, the means by which the heart works disproportionately harder in surplus of the metabolic

demands of the body may be different (Obrist, 1981). Future research should examine the relationship between socioeconomic status and cardiovascular reactivity using a combination of acute psychological stressors including cognitive, interpersonal and physical tasks that may more closely mimic various stressors posed by the naturally occurring environment experienced by individuals along the SES continuum.

Additionally, since the Boylan, Cundiff and Matthews (2018) research was a meta-analysis, a variety of socioeconomic status indicators were acknowledged that essentially only included objective means such as the Hollingshead index, education, occupation, income and neighborhood SES. As previously stated, the present study intentionally juxtaposed subjective and objective indicators of SES in order to acknowledge the strength of subjective measures in relation to health outcomes specifically while simultaneously upholding the long-standing favor in the field for objective measures. It has yet to be established whether this difference in measurement will lead to differing outcomes. Future research should examine differences between the experience of subjective socioeconomic status as comprised of the assessment of current and future prospects (Singh-Manoux, Marmot, & Adler, 2005) versus the expression of objective socioeconomic status as a position at the individual, familial and community levels (McEwen and Gianaros, 2010).

Lastly, the previous meta-analysis focused on recovery as the key mechanism linking low SES and risk for cardiovascular disease as opposed to reactivity, which hasn't been studied as much and tends to be more relevant for older adults and stress tasks that are physical, rather than psychological, in nature (Boylan, Cundiff, & Matthews, 2018). Given the current study examined younger individuals under psychological stress

conditions, it is possible that the relevance of the Boylan, Cundiff and Matthews (2018) findings are not contradictory but rather expand the body of research pertaining to type of SES measure, effects of age on the cardiovascular system and type of stressor utilized. Future research should examine whether different methods of assessing socioeconomic status, stress and cardiovascular functioning reveal different relationships to health outcomes.

The outcomes of the current study support the competing claims regarding the reactivity and blunted hypotheses by revealing differences obtained in the assessment of subjective versus objective SES. Traditional protocols focused on objective measures of SES for a variety of reasons perhaps including ease of assessment and apparent impartiality of responses. For example, results from a Canadian national survey indicated that actual absolute socioeconomic status (household income, personal income and education) were strongly related to self-rated health status, while perceive relative SES results were mixed (Dunn, Veenstra, & Ross, 2005). If the present study only examined subjective SES, then a potential for partiality exists in that objective measures have been found to occur both concurrently and (Baron-Epel and Kaplan, 2009) and independently (Nobles, Weintraub, & Adler, 2013) of subjective measures. However, in conducting a two study thesis, the first of which examined only subjective SES and the second both subjective and objective SES, it is evident that the assessment strategies and operationalization of terminology yield drastically different results. In order to determine how low SES contributes to cardiovascular disease via exaggerated or blunted reactivity, it is important to distinguish which individuals are most at risk in order to protect against potentially long-term health risks. In the United States, economic inequality is on the rise

with a greater portion of income and wealth allocated to upper SES individuals while a corresponding rise in impoverishment exists for racial minorities in particular (Massey and Denton, 1993). Nonetheless, it appears as though other factors may be just as influential: after adjusting for behavioral risk factors, significant associations were found between parental SES and cardiovascular disease risk during adulthood (Steptoe and Marmot, 2002). As such, examining cardiovascular reactivity across multiple domains of measuring socioeconomic status is necessary in order to differentiate at-risk populations based on a variety of factors, providing a more comprehensive perspective.

Interestingly, the subjective components of socioeconomic status were not found to be related to cardiovascular reactivity in Study 2. It is possible that the lack of findings can be attributed to the age, race/ethnicity, sex and recruitment of participants (for review, see: Walsemann, Goosby, & Farr, 2016; Panagiotakos and Kouvari, 2018; Uchino, Holt-Lunstad, Bloor, & Campo, 2005), producing a somewhat homogeneous sample. Specifically, participants were undergraduate students at a private university. Prior research comparing subjective and objective indicators of SES among White women as predictors of both psychological and physical health factors also lacked diversity in terms of age, race/ethnicity and sex yet still found that subjective SES served as a more consistent indicator of greater strength than objective SES for both outcome measures (Adler, Epel, Castellazzo, & Ickovics, 2000). Prior research has questioned the choice of using the MacArthur Scale of Subjective Social Status to measure the constructs of socioeconomic status among minority populations (e.g., Shaked, Williams, Evans, & Zonderman, 2016; Wolff, Acevedo-Garcia, Subramanian, 2010). This suggests that subjective SES may influence cardiovascular disease risk beyond that associated

with objective SES for Whites, but the relationship may be more complicated for minority or underrepresented populations (Allen, McNeely, Waldstein, Evans, & Zonderman, 2014). In Study 1, 51.7% of participants were Caucasian, and in Study 2, 62.6%. The non-statistically significant results in Study 2 for subjective SES may relate to the majority White population, but it is difficult to discern if the higher percentage of White participants reasonably impacted the SES relationship for subjective versus objective measures. If so, perhaps the subjective SES measure, as indicated by the statistical significance of the more diverse racial/ethnic sample in Study 1, is more representative of the status for various racial and ethnic minorities. Lastly, it is quite possible that the lack of findings was due to a true lack of relationship between subjective socioeconomic status and cardiovascular reactivity. As previously mentioned, it has been predicted that the various components may be predictive of different health outcomes, so perhaps non-cardiovascular related issues may be more prevalent for certain under-studied populations (e.g., Williams, 1999; Shavers, 2007; Baron-Epel and Kaplan, 2009). Future research should aim to examine the relationship between subjective SES and health outcomes specifically for minority populations in terms of age, race/ethnicity, sex and other demographic criteria.

Limitations

This research is not without limitations. First, the study was dependent upon self-report data and was correlational in methodology which prevents the determination of causality (Smith, 2004). While it is possible that lower socioeconomic status may relate to cardiovascular reactivity and psychological stress in negative way, whether it be blunted in the case of subjective SES or exaggerated in the case of objective SES, such

determination of causality is not definitive in observational research due to possible unmeasured or poorly measured variables confounding the results. For example, in Study 2, participants were asked to indicate their highest parental occupational status rather than providing their own. While this served a practical purpose to accommodate for the largely undergraduate student sample, one's parental occupation may have skewed the objective SES scale in the positive direction, resulting in the negative correlation with cardiovascular reactivity.

Second, the measure of socioeconomic status was self-determinant in terms of both highest parental occupational status and ranking on the MacArthur Scale of Subjective Social Status and administered at a single laboratory visit. As discussed by Adler and Stewart (2007), the aim of the ladder is to allow for individual discretion in weighing the various components of socioeconomic status, yet this obviously lacks objectivity and may be difficult to compare across individuals' differing assessments. These discrepancies attempt to be accounted for in the two versions of the scale in which members of poorer communities may achieve a high standing within specific social groups (Zell, Strickhouser, & Krizan, 2018), yet the community standing was not assessed due to the perceived demographics comprising the subject pool. By excluding the acknowledgement of status applicable primarily to underdeveloped countries, particular people in the sample could have still felt misrepresented. With regards to the Hollingshead (1975) description of the stability of occupational status, it is necessary to acknowledge the issues involved with inquiring about parental occupation. For any demographic, this information may be inaccessible due to a lack of contact or insight regarding the parent with the highest-attained occupation status. Additionally,

generational differences may necessitate that older participants' parents had differential access to careers based on traditional gender roles (Dolado, Felgueroso, Jimeno, 2001) or that is was not as normative as it may be for younger participants' parents to participate dual-working households (Leonce, 2020). The difference particularly among the age of participants may distinguish between whether the individual's own occupation status may be more predictive of objective SES.

Third, the observed associations between socioeconomic status and cardiovascular reactivity were relatively small in both Study 1 and Study 2. The correlation values in Study 1 relating subjective socioeconomic status to cardiovascular reactivity ranged from .24 to .29, though both values were statistically significant. Similarly, the correlation values in Study 2 relating objective socioeconomic status to cardiovascular reactivity ranged from -.22 to -.26, though both values were statistically significant. However, these values are comparable to much of the literature pertaining to cardiovascular stress reactivity (Boylan, Cundiff, & Matthews, 2018). On the contrary, the non-statistically significant correlations relating subjective socioeconomic status to cardiovascular reactivity were -.11 and -.06, representing very weak to no relationship. Importantly, an outlier was removed from the analyses pertaining to subjective SES and cardiovascular reactivity in Study 2. With this individual included, the correlations became more meaningful in both magnitude and statistical significance. However, this participant's score on the MacArthur Scale of Subjective Social Status was a 1, representing the lowest possible value and as such was more than 2 standard deviations below the mean.

Lastly, it may have been helpful to have acquired a more comprehensive profile of reactivity rather than simply focusing on blood pressure and heart rate. Other cardiovascular indicators such as inflammation (Gruenewald, Cohen, Matthews, Tracy, & Seeman, 2009), salivary cortisol (Hajat et al., 2010) as well as stroke volume and cardiac output (Steptoe, Willemsen, Kunz-Ebrecht, & Owen, 2003) have an established relationship with SES. In addition, prior research has also demonstrated a correlation between socioeconomic status and chronic conditions such as hypertension, diabetes, cancer, lung disease, heart condition, stroke and arthritis (Smith, 1998) as well as self-rated health, depression, long-standing illness and high-density lipoprotein cholesterol (Demakakos, Nazroo, Breeze, & Marmot, 2008) that may be measured via different means beyond the scope of the cardiovascular system.

Future Directions

Future research should continue to examine the proposed relationships and underlying mechanisms between socioeconomic status and cardiovascular disease outlined in this study. Socioeconomic status is proposed to be related to cardiovascular disease through individual differences in cardiovascular responses to psychological stress, which may further be influenced by a variety of external factors (e.g., individual-level elements of social capital, residential neighborhood problems and ecologic-level indicators of SES; see Table 2.3). The results of the current study suggest a need for the continued separate examination of the objective and subjective components of socioeconomic status and how they differently relate to health outcomes. Additionally, it may be informative to examine these socioeconomic determinants utilizing a variety of assessment methods, such as other various forms of self-report questionnaires, standard

interviews and available archive data. Furthermore, the subjective stress ratings of the PASAT must be taken into consideration. Due to the various forms of stress-inducing tasks and situations available, a natural setting would perhaps elicit different physiological responses. Though several means of invoking stress were present, including the video camera, mirror, buzzer and rater, individual differences in the perception of the laboratory setting may have influenced indicators of stress assessed via a self-report questionnaire. Other opportunities for measurement include various forms of inducing stress, means of defining socioeconomic status and assessing cardiovascular reactivity.

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