Lower Perceived Socioeconomic Status is Associated with Exaggerated Cardiovascular Reactivity to Stress

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11/25/2014

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Abstract

Cardiovascular reactivity to mental stress is a known predictor of future cardiovascular health. Stress response is regulated by the hypothalamo-pituitary-adrenal (HPA) axis and can be altered by repeated activation (Gruenewald et al., 2012). Chronic stress from growing up in a lower socioeconomic status (SES) community can change how the HPA axis responds to acute stress (McEwen & Gianaros, 2010). This study investigated the relationship between SES and cardiovascular reactivity in young adults. SES was measured on both the community and US based MacArthur Scales of Subjective Social Status (Adler & Stewart, 2007). Systolic blood pressure (SBP), diastolic blood pressure (DBP), pulse and mean arterial pressure (MAP) were measured throughout the PASAT, a cognitive stress task (Carroll, Phillips, & Balanos, 2009). SBP reactivity ($F(1, 24)= 4.633$, $p= 0.42$, $\eta_p^2= 0.162$) and MAP reactivity ($F(1, 24)= 4.314$, $p= 0.049$, $\eta_p^2= 0.152$) were significantly different between high community SES group and low community SES group but not the US SES groups. These findings support other findings correlating SBP with SES in other age groups and the effects of remodeling in the amygdala (Brummett et al., 2011; McEwen, 2007).

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Socioeconomic Status and the Distribution of Disease

Place in society impacts health independent from access to care, quality of medical knowledge and cultural context (Wadsworth & Butterworth, 2006). The gap between the so called have's and have not's in the world has been rising since the 1980's, exacerbating this problem (UN DESA, 2006). This is without considering the people whose total consumption of goods and services after their healthcare expenditures is below the poverty line (van Doorslaer & O'Donnell, 2011). A gradient of health exists meaning that as position in the social hierarchy descends so does health (Marmot, 2013). This can be seen in the distribution of morbidity and mortality in most populations (Adler et al., 1994).

This distribution can easily be seen in disease like preventable type 2 diabetes. In the Third National Health and Nutrition Examination Survey done in the United States, it was found that percentage of the poverty line was most closely associated with the prevalence of type 2 diabetes (Robbins, Vaccarino, Zhang, & Kasl, 2001). Education level and occupation (blue-collar vs. white-collar work) has also been linked with a higher risk of developing diabetes (Maty, Everson-Rose, Haan, Raghunathan, & Kaplan, 2005). The prevalence of diabetes is distributed along the same gradient of disease as a number of other major illnesses as they are all influenced by the same issues of social hierarchy (Everson, Maty, Lynch, & Kaplan, 2002; Adler et al., 1994; Marmot, 2013)

Cardiovascular disease is also found in a dose-response relationship with socioeconomic status (SES) in the United States (Allen, 2000). In 2013, those with a high school education or lower had a 52.5% prevalence of two or more traditional risk factors for heart disease and stroke while those with a college degree had a 25.9% prevalence rate (Go et al., 2013). It has been

found, even in young adults, that a low SES can impact cardiovascular health, particularly systolic blood pressure and heart rate (Brummett et al., 2011).

While the connection between SES and health is clear it is also thought by some economists to be bi-directional (Smith, 1999; Marmot, 2013). The gradient of health has also been found in countries with universal healthcare showing access to care is not the sole cause of these inequalities (Cohen, Janicki-Deverts, Chen, & Matthews, 2010). Many health variables correlate with SES like birth weight, nutrition and environmental conditions, but stress is thought to be a major link between SES and health (Gruenewald et al., 2012). Being of or perceiving oneself as being of a lower socioeconomic status increases a person's stress burden (Singh-Manouz, Marmot, & Adler, 2005). Not only does stress have psychological impacts but stress also has widespread effects on multiple organ systems and causes restructuring in the brain areas that respond to stress (McEwen & Gianaros, 2010).

Culture and Societies

Culture can also impact how stress is perceived. Western cultures are classified as individualistic or the central unit of society is the individual (Chun, Moos, & Cronkite, 2006; O'Connor & Shimizu, 2002). Eastern cultures are oriented towards collectivism where groups are the main unit in society. These different sets of social priorities can also mean a difference in how stress is coped with based on the culture in which a person was raised (Hobfoll, 1998). In one study, O'Connor and Shimizu (2002) found that Japanese students were more likely to use emotion-focused copping strategies when dealing with stress than British students. While how stress is handled may differ across countries, the impact of stress on cardiovascular disease in the developed world remains the same. A seven country study showed that the relative risk of dying

from coronary heart disease for a given increase in blood pressure overtime was similar despite cultural differences (van den Hoogen et al., 2000).

SES, Health and the Impacts of Stress

In the United States, stress has been found at higher rates in a number of systematically oppressed groups. As Cohen and Janicki-Deverts (2012) demonstrated, women have higher stress levels than men, minorities have higher stress than whites and perceived stress levels decrease with increasing age, education and income. It has been found that being aware of one's place in the hierarchy of society impacts recovery from stressors, emotional patterns, behavior and psychological reactions (McEwen & Gianaros, 2010).

During childhood, long term stress can have a large impact as the brain is still developing (Wadsworth & Butterworth, 2006) and is more vulnerable to the effects of stress than adults (Chrousos, 2009). Lower SES living conditions in childhood, can impact physiological responses to the environment (Evans, 2004). Children who grow up in lower SES families are more likely to be exposed to any number of the following psychosocial exposures: risky families, nonfamily presence, poor health habits in parents, crime, violence, lower social capital, schools with little order, lower quality education, negative school climate (Cohen et al., 2010; Evans, 2004). All of these may contribute to a chronic stress inducing environment, which can cause dysregulation of mental and physical systems (Cohen et al., 2010). Dysregulation of biological systems because of chronic stress exposure can lead to anxiety, depression, hostility (Smith, 2012; Wadsworth & Butterworth, 2006), immune dysregulation (Cohen et al., 2010), social isolation (Brunner & Marmot, 2006), diabetes (Everson et al., 2002), obesity, cardiovascular disease and abnormal cardiovascular reactivity (Matthews, Woodall, & Allen, 1993).

Cardiovascular Reactivity and Allostatic Load

Cardiovascular reactivity, or changes in blood pressure caused by a mental stressor is an indicator of future health (Allen, 2000; Matthews et al., 1993). A healthy pattern of reactivity to mental stress involves a quick return to baseline blood pressure and is not thought to be damaging to the body; however repeated responses from repeated stressors can result in an abnormal reactivity (Brunner & Marmot, 2006). One common abnormal reactivity pattern involves a sharp response to a stimulus and a slow return to baseline. Exaggerated reactivity has been found to be a predictor for increased blood pressure over time, carotid atherosclerosis (Chen & Matthews, 2001), ventricular hypertrophy (Gianaros, Jennings, Sheu, Derbyshire, & Matthews, 2007) hypertension and stroke (Gianaros et al., 2008;). One theory of how cardiovascular reactivity impacts health is the allostatic load theory (Brunner & Marmot, 2006).

Allostatic load is the wear on the body and brain caused by dysregulation of the systems that respond to the environment often from stressful experiences or changes in lifestyle as a result of stress (Allen, 2000). The organs that are involved in stress symptoms are often affected by allostatic load and this can lead to a number of diseases (Roy, 2004). Additionally, the brain is often the target of stress response hormones that can result in restructuring of neuronal connections (McEwen, 2007). Stress systems such as the hypothalamo-pituitary-adrenal (HPA) axis can cause remodeling in a number of areas in the brain when it is repeatedly activated and is one of the many causes of increased allostatic load.

Neurological Systems

One of the primary systems regulating stress responses is the HPA axis. When the brain perceives something as stressful, the hypothalamus releases corticotropin-releasing hormone (CRH) to the anterior pituitary via the hypophyseal portal circulation (Brunner & Marmot, 2006;

Miller, Chen, & Zhou, 2007). The anterior pituitary then releases adrenocorticopin hormone (ACTH) which stimulates the adrenal gland to release glucocorticoids like cortisol into the bloodstream. The HPA axis works as a negative feed-back loop, and cortisol inhibits the release of both CRH and ACTH (Brunner & Marmot, 2006). In addition, cortisol helps regulate metabolism, the immune system and vascular reactivity (Chrousos, 2009). The hippocampus and amygdala are involved in regulating the HPA axis, and both areas can be impacted by repeated stress causing dysregulation of the HPA axis.

The hippocampus serves to inhibit the HPA axis (Roy, 2004). CRH activates the hippocampus which in turn down regulates the hypothalamus and stops the HPA axis. CRH also serves as a mediator for plasticity in the hippocampus. Repeated stress and therefore repeated CRH exposure can suppress neurogenesis, decrease cell survival, cause dendrites to contract and simplify and reduce spine synapses (Chrousos, 2009; McEwen, 2007). This restructuring decreases the effectiveness of the negative feedback keeping the HPA axis in check and therefore causes more HPA activity (McEwen & Gianaros, 2010; Roy, 2004).

The amygdala, on the other hand, helps maintain homeostatic blood pressure but also up regulates the HPA axis during stress response via projections from the central nucleus of the amygdala (Saha, 2005). The bareoflex maintains arterial pressure at or around a set point by sending signals to the nucleus of the solitary tract (NTS) in the brain stem (Guyenet, 2006). The NTS can either up regulate BP via neurons in the sympathetic nervous system or down regulate it via neurons in the parasympathetic nervous system (Gianaros et al., 2008). The NTS sends excitatory signals to the caudalventrolateral medulla (CVLM) which inhibit parasympathetic nuclei in the rostral ventrolateral medulla (RVLM) (Gianaros et al., 2008; Guyenet, 2006; Saha, 2005). The RVLM is a primary regulator of the sympathetic nervous system, and it signals

sympathetic ganglion neurons in the spinal cord which affect heart rate, cardiac output and vascular resistance to maintain a contextually appropriate set-point (Guyenet, 2006).

Under stress conditions, the amygdala can override the signals from the bareoflex and force BP above the set point (Gianaros et al., 2008). The amygdala sends inhibitory signals to the NTS and excitatory signals to the RVLM, effectively shutting down parasympathetic control over blood pressure and causing increases in heart rate, cardiac output and vascular resistance (Gianaros et al., 2008; Guyenet, 2006). Like the hippocampus, repeated stress can cause remodeling in the amygdala as well (McEwen, 2007).

Unlike the hippocampus, repeated stress cause the amygdala to make more dendritic connections (McEwen, 2007). It has also been found that people who had greater amygdala response to threatening cues also had higher levels of preclinical atherosclerosis (McEwen & Gianaros, 2010), as the amygdala is both responsible for BP and control of emotions (Chrousos, 2009). Lower SES in childhood was found to be associated with greater amygdala reactions to threatening faces in the fMRI. The amygdala has been found to be partially responsible for processing social emotional stimuli and human hierarchies as it is responsible for associating emotion, environment and solution (Roy, 2004; Zink et al., 2008). So long term changes to the amygdala can cause persistent changes in how a person reacts to their environment.

Cardiovascular Reactivity

This study examined whether lower childhood SES is associated with cardiovascular reactivity in young adults. For this study, SES was measured using the MacArthur Scale of Subjective Social Status. The subjective scale allows an individual to weight their own experiences considering a greater understanding of their own history, current status and anticipated situation (Gianaros & Manuck, 2010). The MacArthur scale has been found to

correlate well with objective measures such as education, income and occupation, but it also captures a relationship between SES and health indicators that is not seen as strongly with purely objective measures (Adler & Stewart, 2007; Hu, Adler, Goldman, Weinstein, & Seeman, 2005). This study hypothesized that lower childhood SES is associated with abnormal reactivity to a cognitive stress task than those with higher childhood SESs.

Methods

Participants

Thirty-five undergraduate students age M = 19.66 (SD=1.14), 63% female (n=22) and 74% identified as Caucasian alone (n=26) (see Table 1) were recruited via word of mouth and social media announcements. They provided informed consent (see appendix A) and filled out an online demographic survey upon signing up for the study (see appendix B). Students in Introductory Psychology classes were offered participation credits and students in Introductory Global Health classes were granted extra credit for participating. Participants were told the study was looking at previous life experiences and health behaviors as to not single out students of lower SES. Additionally, they were asked to complete the Pittsburgh Sleep Quality Index (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989) and answer questions about their exercise habits to mask the aim of the study. This project was approved by the Allegheny College Institutional Review Board.

Socioeconomic Status Measure

SES was measured using two modified MacArthur Subjective Social Status Scales (Adler & Stewart, 2007). The first scale presented a 10-rung ladder and asked participants to

> Think of this ladder as representing where people stand in their communities. People define community in different ways; please define it in whatever way is most meaningful

> to you. At the top of the ladder are people who have the highest standing in their community. At the bottom are people who have the lowest standing in their community. Thinking back to your childhood, where would you place yourself on this ladder? (Adler & Stewart, 2007)

The second scale showed the same ladder and asked participants to

> Think of this ladder as representing where people stand in the United States. At the top of the ladder are the people who are the best off- those who have the most money, the most education, and the most respected jobs. At the bottom are the people who are the worst off- who have the least money, least education and the least respected jobs or no job. Thinking back to your childhood, where would you place yourself on this ladder? (Adler & Stewart, 2007)

Participant's SES scores permitted coding into two groups. The first group was determined by responses to the community SES scale. Those who ranked themselves on the 5th rung and below were placed in the low SES category (n=13) while those who marked above the 5th rung were placed in the high SES category (n=17). The second group was determined by response to the US SES ladder and the same qualifications were used to code them into high SES (n=18) or low SES (n=12).

Cognitive Stress Task

Participants came into the lab and were asked to sit in a separate room from the researcher. They were monitored throughout using a video monitoring system to guarantee compliance with instructions. A blood pressure cuff was placed on participant's non-dominant arm to record mean arterial pressure (MAP), pulse, systolic blood pressure (SBP), and diastolic blood pressure (DBP) throughout the task.

The paced auditory serial addition task (PASAT) (Carroll et al., 2009) was used as the mental stressor. It began with a 10 minute rest period to collect baseline readings. This was followed by the 10 minute stress task of serial addition in which the pace of the task increase in speed as it progressed and ended with a 10 minute recovery period (Carroll et al., 2009). During the stress period, participants were asked to stare straight ahead at a mirror in front of them. An element of competition was also used to increase the mental stress of the task as participants were told that they were competing with each other. Fake competitors' scores were displayed in the testing room. The participant's BP, MAP and pulse were taken (Critikon Dinamap Vital Signs Monitor 1846 SX) every two minutes through the 30 minute task.

The number of skipped answers and wrong answers given on the task were recorded. A post study questionnaire was issued after the recovery period. It asked participants to rate on a Likert scale from 0 to 6 how stressful, engaging and difficult they perceived the task. They were also asked to rate how accurate they thought their answers were and how well they thought they coped with the stress of the task.

Statistical Analysis

An independent samples T-tests was run on age and chi squared tests were run on sex, race, childhood neighborhood, and smoking status to check for comparative distribution. Mean scores for MAP, pulse, SBP and DBP were found for baseline recordings from the final three recordings in the baseline period. The remaining means were calculated from all five recorded scores for each phase. Independent samples t-test were run on all of the mean reactivity scores to check for differences between the groups. Repeated measures analyses of variance (ANOVAs) were run on the average scores in order to confirm change between baseline and stress periods for each cardiovascular measure. Reactivity was calculated by taking the mean stress scores and

subtracting the mean baseline scores. The reactivity scores were analyzed with a one-way analysis of covariance's (ANCOVA) for a difference between low SES and high SES groups by both the community and US scales. Age, sex, race and smoking status were used as covariates.

Results

Demographics and Physiological Measures

Five participants were excluded from analysis because one or more of their reactivity scores was two standard deviations from the mean. There were no significant demographic differences between the groups except for the childhood neighborhood for the US MacArthur scale groups (χ^2 (2) = 6.67, p = .04). As expected, repeated measures ANOVAs showed a significant overall change between the baseline, stress, and recovery period for MAP (F(1, 29)=15.46, p=.001), pulse (F(1, 29)= 1360.52, p=.001), SBP (F(1,29)= 3183.44, p=.001) and DBP (F(1,29)=4484.38, p=.001) . There were no statistically significant differences in the demographic measures between the low and high SES groups in either the community ladder groups or the US ladder groups (Table 1). The average scores for all four cardiovascular measures were not significant at the baseline period, the stress period or the recovery period for all groupings except for one. The independent samples t-test on the community SES groups showed the difference in the SBP averages at baseline between the low SES group (n= 13, M= 106.18, SD= 8.86) and the high SES group (n= 17, M= 114.37, SD= 11.49) to be statistically significant, t(28)= -2.129, p= 0.042.

Post PASAT Questionnaire Analysis

As can be seen in table 2, there were no significant differences between the SES groups on the community or US MacArthur scale in self rated scores of difficulty, stressfulness, perceived performance, or engagement on the PASAT task (Table 2). The ability to cope scores were found to be significantly lower for community between low SES (n= 13, M= 4.15, SD= 1.35) and high SES (n= 17, M= 5.00, SD= 0.15), t (28)= -2.309, p=0.029).

Reactivity Analysis

The series of ANCOVAs controlling for age, sex, race and smoking status, showed no significance in any of the reactivity means for the US SES scale (Figure 1). As can also be seen in figure 1, both MAP and SBP had significant results for the community scale. The homogeneity-of-regression analysis showed no significant differences in the relationship between the covariates and SES groups as a function of MAP reactivity. The ANCOVA for MAP reactivity was not significant for the covariates (p> .05) but remained significant for the main effect of SES group F(1, 24)= 4.314, p= 0.049, η_p^2= 0.152. The relationship between the SES groups and covariates as a function of SBP reactivity had no significance in the analysis for homogeneity-of-regression. The ANCOVA for SBP was also not significant for the covariates (p> .05) except for age F(1, 24)= 5.231, p=0.031, η_p^2= 0.179, and again significant for the main effect of SES group F(1, 24)= 4.633, p= 0.42, η_p^2= 0.162.

Discussion

SES and SBP Reactivity

The hypothesis that cardiovascular reactivity would differ by perceived SES was partially supported. Childhood SES on the community based MacArthur scale had significant differences between the low SES and high SES groups in terms of cardiovascular reactivity to the mental stressor. The MAP and SBP reactivity for the community MacArthur Scale groups had

significant results though DBP also followed the pattern though it was not found to be significant (Figure 1). This follows with other findings that SBP is more responsive to changing risk factors than DBP (Brummett et al., 2011). This is similar to the results from Taylor et. al (2004) who found that 18- 25 year-olds from risky families, a chronic stress inducing environment, had elevated BP and cortisol levels in response to a cognitive stress task indicating increased HPA axis activity. A weak association between low family SES and higher cardiovascular reactivity has also been found in children 8 to 10 and 15 to 17 (Chen & Matthews, 2001). This reactivity difference between the lower SES group than the higher SES group follows with the expected outcome if the HPA axis were to be deregulated by chronic stress (McEwen & Gianaros, 2010; McEwen, 2007). These reactivity findings support the past research which has linked perceiving oneself as lower in the social hierarchy with neurological restructuring in the amygdala (Gianaros et al., 2009).

The other major significant result is the perceived ability to cope with the stress of the task between the groups on the community SES scale. As the SBP and MAP were significant, the ability to cope scores were not an unexpected result. However it may also relate to some allostatic load theories. Adler at al. (1994) theorized that lower SES status often coincides with fewer personal resources to cope with stress. So while these scores logically correlate with the major finding it may also be an indicator of differences in SES groups.

Only when the groups were categorized according to community based MacArthur scale groups was there a significant difference in reactivity scores. The two scales have been found to measure different aspects of social hierarchies. Adler and Stewart (2007) conducted a study investigating how participants placed themselves on the MacArthur ladders. They found that on the community scale the most frequent consideration was altruistic actions within their

community and the 2nd most frequent consideration was how respected they were. While when rating themselves on the US scale, participants tend to consider more objective measures like wealth, occupation, education, health (Adler & Stewart, 2007; Cohen et al., 2008). The perception of place in the community was found to be more important in terms of cardiovascular health than more objective measures of status.

Ethics and Social Philosophy

The health disparities among socioeconomic groups in the United States as well as on a global scale pose a massive ethical challenge. According to the World Health Organization (WHO) it is the right of every human being to have the highest possible standard of health therefore it can be seen by many as the responsibility of a government to help their citizens meet this standard (Sadana, 2013). While the WHO treats health as a right, the US government does not. This has most recently been reinforced by the Patient Protection and Affordable Care Act which had no mentions of a universal health care system and instead is an individual mandate (Hoffman, 2012). It provides no financial guarantees for individuals or families to afford the insurance or care which is far from the ideal scenario if health care is a right.

There is also pressure from large international bodies. The United Nations has also made clear its' goals to reduce inequalities of health in a number of measures including the Millennium Development Goals (MDG) which have been put forth to all member countries (UN DESA, 2006). While they set lofty goals for reducing global poverty and improving health worldwide, the UN measures offer no clear steps to equitable solutions. Despite promoting equality of rights, they leave steps forward in achieving the MDGs and other goals of reducing other disparities vague and open for inequitable solutions (Daniels, 2013; UN DESA, 2006). The maximizing method targets parts of the population that are easier to access and not necessarily

the worst off in the country (Daniels, 2013). This means the average improves but the inequality within the country also increases. The MDG represent ends but not the means to get there (Haines & Cassels, 2004). Instead, broad scale changes are needed to countries health care systems and the issues of the gradient of health need to be addressed.

While ensuring access to health care makes up a large facet of a government's responsibilities, ultimately no true change can be made without addressing the gradient of health. This can prove to be a more challenging as steps towards an equitable system involves challenging fundamental systems in society (Daniels, 2013). It's a system that penalizes altruism and disadvantages the poor, the vulnerable and the sick (Smith, 2012). If, as seen in this study, factors like SES are associated with measurable aspects of health then the only way to rectify these inequalities is to modify the system that they exist in. As Marmot (2013) states, reducing inequalities is not just about reducing poverty or improving access to care but larger universal solutions.

Limitations

This study had a number of limitations first being the sample size was small. Additionally, the full spectrum of SES was not represented in the sample. Furthermore, the responses were categorized into the two categories even those who marked the middle of the ladder. This could have muffled the results and future research could include a larger sample with more stringent classifications for the SES groups used.

References

Adler, N. E., Boyce, T., Chesney, M. A., Cohen, S., Folkman, S., Kahn, R. L., & Syme, S. L. (1994). Socioeconomic Status and Health: The Challenge of the Grandient. *American Psychologist*, *49*(1), 15– 24.

Adler, N. E., & Stewart, J. (2007, March). The MacArthur Scale of Subjective Social Status. Retrieved September 22, 2014, from http://www.macses.ucsf.edu/research/psychosocial/subjective.php

Allen, M. T. (2000, November). Cardiovascular Reactivity. Retrieved November 21, 2014, from http://www.macses.ucsf.edu/research/psychosocial/reactivity.php

Brummett, B. H., Babyak, M. A., Siegler, I. C., Shanahan, M., Harris, K. M., Elder, G. H., & Williams, R. B. (2011). Systolic Blood Pressure, Socioeconomic Status, and Biobehavioral Risk Factors in a Nationally Representative US Young Adult Sample. *Hypertension*, *58*(2), 161–166. doi:10.1161/HYPERTENSIONAHA.111.171272

Brunner, E., & Marmot, M. (2006). Social Organization, Stress, and Health. In M. Marmot & R. G. Wilkinson (Eds.), *Social Determinants of Health* (2nd ed., pp. 6–30). Oxford University Press.

Buysse, D. J., Reynolds, C. F., Monk, T. H., Berman, S. R., & Kupfer, D. J. (1989). The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. *Psychiatry Research*, *28*(2), 193–213.

Carroll, D., Phillips, A. C., & Balanos, G. M. (2009). Metabolically exaggerated cardiac reactions to acute psychological stress revisited. *Psychophysiology*, *46*(2), 270–275. doi:10.1111/j.1469-8986.2008.00762.x

Chen, E., & Matthews, K. A. (2001). Cognitive appraisal biases: An approach to understanding the relation between socioeconomic status and cardiovascular reactivity in children. *Annals of Behavioral Medicine*, *23*(2), 101–111. doi:10.1207/S15324796ABM2302_4

Chrousos, G. P. (2009). Stress and disorders of the stress system. *Nature Reviews Endocrinology*, *5*(7), 374+.

Chun, C.-A., Moos, R. H., & Cronkite, R. C. (2006). Culture: A fundamental context for the stress and coping paradigm. In *Handbook of multicultural perspectives on stress and coping* (pp. 29–53). Springer. Retrieved from http://link.springer.com/chapter/10.1007/0-387-26238-5_2

Cohen, S., Alper, C. M., Doyle, W. J., Adler, N., Treanor, J. J., & Turner, R. B. (2008). Objective and subjective socioeconomic status and susceptibility to the common cold. *Health Psychology*, *27*(2), 268–274. doi:10.1037/0278-6133.27.2.268

Cohen, S., & Janicki-Deverts, D. (2012). Who's Stressed? Distributions of Psychological Stress in the United States in Probability Samples from 1983, 2006, and 20091: PSYCHOLOGICAL STRESS IN THE U.S. *Journal of Applied Social Psychology*, *42*(6), 1320–1334. doi:10.1111/j.1559-1816.2012.00900.x

Cohen, S., Janicki-Deverts, D., Chen, E., & Matthews, K. A. (2010). Childhood socioeconomic status and adult health: Childhood socioeconomic status and adult health. *Annals of the New York Academy of Sciences*, *1186*(1), 37–55. doi:10.1111/j.1749-6632.2009.05334.x

Daniels, N. (2013). Reducing Health Disparities: No Simple Matter. In N. Eyal, S. Hurst, O. F. Norheim, & D. Wikler (Eds.), *Inequalities in Health: Concepts, Measures and Ethics* (pp. 178–196). Oxford University Press.

Evans, G. W. (2004). The Environment of Childhood Poverty. *American Psychologist, 59*(2), 77–92. doi:10.1037/0003-066X.59.2.77

Everson, S. A., Maty, S. C., Lynch, J. W., & Kaplan, G. A. (2002). Epidemiologic evidence for the relation between socioeconomic status and depression, obesity, and diabetes. *Journal of Psychosomatic Research, 53*, 891– 895.

Gianaros, P. J., Jennings, J. R., Sheu, L. K., Derbyshire, S. W. G., & Matthews, K. A. (2007). Heightened Functional Neural Activation to Psychological Stress Covaries With Exaggerated Blood Pressure Reactivity. *Hypertension*, *49*(1), 134–140. doi:10.1161/01.HYP.0000250984.14992.64

Gianaros, P. J., & Manuck, S. B. (2010). Neurobiological Pathways Linking Socioeconomic Position and Health. *Psychosomatic Medicine, 72*(5), 450–461. doi:10.1097/PSY.0b013e3181e1a23c

Gianaros, P. J., Sheu, L. K., Matthews, K. A., Jennings, J. R., Manuck, S. B., & Hariri, A. R. (2008). Individual Differences in Stressor-Evoked Blood Pressure Reactivity Vary with Activation, Volume, and Functional Connectivity of the Amygdala. *The Journal of Neuroscience*, *28*(4), 990–999. doi:10.1523/JNEUROSCI.3606-07.2008

Gianaros, P. J., Sheu, L. K., Remo, A. M., Christie, I. C., Crtichley, H. D., & Wang, J. (2009). Heightened Resting Neural Activity Predicts Exaggerated Stressor-Evoked Blood Pressure Reactivity. *Hypertension, 53*(5), 819–825. doi:10.1161/HYPERTENSIONAHA.108.126227

Go, A. S., Mozaffarian, D., Roger, V. L., Benjamin, E. J., Berry, J. D., Borden, W. B., … Turner, M. B. (2013). Heart Disease and Stroke Statistics—2013 Update A Report From the

American Heart Association. *Circulation*, *127*(1), e6–e245. doi:10.1161/CIR.0b013e31828124ad

Gruenewald, T. L., Karlamangla, A. S., Hu, P., Stein-Merkin, S., Crandall, C., Koretz, B., & Seeman, T. E. (2012). History of Socioeconomic Disadvantage and Allostatic Load in Later Life. *Social Science & Medicine (1982)*, *74*(1), 75–83. doi:10.1016/j.socscimed.2011.09.037

Guyenet, P. G. (2006). The sympathetic control of blood pressure. *Nature Reviews Neuroscience*, *7*(5), 335–346. doi:10.1038/nrn1902

Haines, A., & Cassels, A. (2004). Can the millennium development goals be attained? *BMJ : British Medical Journal*, *329*(7462), 394–397.

Hobfoll, S. E. (1998). *Stress, culture, and community: the psychology and philosophy of stress*. New York: Plenum Press.

Hoffman, B. R. (2012). *Health care for some: rights and rationing in the United States since 1930*. Chicago: The University of Chicago Press.

Hu, P., Adler, N. E., Goldman, N., Weinstein, M., & Seeman, T. E. (2005). Relationship between subjective social status and measures of health in older Taiwanese persons. *Journal of the American Geriatrics Society*, *53*(3), 483–488.

Marmot, M. (2013). Fair Society Healthy Lives. In N. Eyal, S. Hurst, O. F. Norheim, & D. Wikler (Eds.), *Inequalities in Health: Concepts, Measures and Ethics* (pp. 282–297). Oxford University Press.

Matthews, K. A., Woodall, K. L., & Allen, M. T. (1993). Cardiovascular reactivity to stress predicts future blood pressure status. *Hypertension*, *22*(4), 479–485.

Maty, S. C., Everson-Rose, S. A., Haan, M. N., Raghunathan, T. E., & Kaplan, G. A. (2005). Education, income, occupation, and the 34-year incidence (1965–99) of Type 2 diabetes in the Alameda County Study. *International Journal of Epidemiology*, *34*(6), 1274–1281. doi:10.1093/ije/dyi167

McEwen, B. S. (2007). Physiology and Neurobiology of Stress and Adaptation: Central Role of the Brain. *Physiological Reviews*, *87*(3), 873–904. doi:10.1152/physrev.00041.2006

McEwen, B. S., & Gianaros, P. J. (2010). Central role of the brain in stress and adaptation: Links to socioeconomic status, health, and disease. *Annals of the New York Academy of Sciences*, *1186*(1), 190–222. doi:10.1111/j.1749-6632.2009.05331.x

Miller, G. E., Chen, E., & Zhou, E. S. (2007). If it goes up, must it come down? Chronic stress and the hypothalamic-pituitary-adrenocortical axis in humans. *Psychological Bulletin*, *133*(1), 25–45. doi:10.1037/0033-2909.133.1.25

O'Connor, D. B., & Shimizu, M. (2002). Sense of personal control, stress and coping style: a cross-cultural study. *Stress and Health*, *18*(4), 173–183. doi:10.1002/smi.939

Robbins, J. M., Vaccarino, V., Zhang, H., & Kasl, S. V. (2001). Socioeconomic status and type 2 diabetes in African American and non-Hispanic white women and men: evidence from the Third National Health and Nutrition Examination Survey. *American Journal of Public Health*, *91*(1), 76–83.

Roy, J.-P. (2004). Socioeconomic status and health: a neurobiological perspective. *Medical Hypotheses*, *62*(2), 222–227. doi:10.1016/S0306-9877(03)00315-3

Sadana, R. (2013). Reflections on Global Monitoring of Social Determinants of Health and Health Equity. In N. Eyal, S. Hurst, O. F. Norheim, & D. Wikler (Eds.), *Inequalities in Health: Concepts, Measures and Ethics* (pp. 307–332). Oxford University Press.

Saha, S. (2005). Role of the Central Nucleus of the Amygdala in the Control of Blood Pressure: Descending Pathways to Medullary Cardiovascular Nuclei. *Clinical and Experimental Pharmacology and Physiology*, *32*(5-6), 450–456. doi:10.1111/j.1440-1681.2005.04210.x

Singh-Manouz, A., Marmot, M., & Adler, N. (2005). Does subjective social status predict health and change in health status better than objective status? *Psychosomatic Medicine*, *67*, 855– 861.

Smith, J. P. (1999). Healthy Bodies and Thick Wallets: The Dual Relation Between Health and Economic Status. *The Journal of Economic Perspectives : A Journal of the American Economic Association*, *13*(2), 144–166.

Smith, P. (2012). Justice, Health, and the Price of Poverty. In R. Rhodes, M. P. Battin, & A. Silvers (Eds.), *Medicine and social justice: essays on the distribution of health care* (2nd ed., pp. 255– 263). New York, NY: Oxford University Press.

Taylor, S. E., Lerner, J. S., Sage, R. M., Lehman, B. J., & Seeman, T. E. (2004). Early environment, emotions, responses to stress, and health. *Journal of Personality*, *72*(6), 1365– 1394.

UN DESA. (2006). *Social justice in an open world: the role of the United Nations.* New York: United Nations.

Van den Hoogen, P. C. W., Feskens, E. J. M., Nagelkerke, N. J. D., Menotti, A., Nissinen, A., & Kromhout, D. (2000). The Relation between Blood Pressure and Mortality Due to Coronary Heart Disease among Men in Different Parts of the World. *New England Journal of Medicine*, *342*(1), 1–8. doi:10.1056/NEJM200001063420101

Van Doorslaer, E., & O'Donnell, O. (2011). Measurement and Explanation of Inequality in Health and Health Care in Low-Income Settings. In M. McGillivray, I. Dutta, & D. Lawson (Eds.), *Health Inequality and Development* (pp. 20– 44). United Nations University.

Wadsworth, M., & Butterworth, S. (2006). Early Life. In M. Marmot & R. G. Wilkinson (Eds.), *Social Determinants of Health* (2nd ed., pp. 31– 53). Oxford University Press.

Zink, C. F., Tong, Y., Chen, Q., Bassett, D. S., Stein, J. L., & Meyer-Lindenberg, A. (2008). Know Your Place: Neural Processing of Social Hierarchy in Humans. *Neuron*, *58*(2), 273–283. doi:10.1016/j.neuron.2008.01.025

Appendix A: Consent Form

Consent Form
Purpose: This project is a research study for a senior comp. The purpose is to examine how previous life experiences and health behaviors impact cardiovascular responses to stress.

Procedure: You will first be asked to answer some questionnaires about your previous life experience and some of your current health behaviors. After, you may be asked to come into the lab to do a mental stress task while wearing a blood pressure cuff which will periodically record your blood pressure and pulse. This is followed by a brief questionnaire about the task itself. It should take approximately 45 minutes to an hour to complete this study.

Confidentiality: Your name will not be connected to the data collected only your SONA ID number. Identifying information will not be included in any report and will only be accessible to the researchers.

Benefits and Risks: In participating in this study you help add to the general body of knowledge. Risks include some discomfort you may have from doing a stressful task, wearing a blood pressure cuff or answering personal questions.

Participating in this study is completely voluntary and you may refuse to continue the study at any time. You may also decline to answer specific questions or decline to continue tasks that you do not want to do. There will be no consequences for not participating or for not completing a section of this study.

Contact Information: If you have any questions about this study please contact Lee Ann Adelsheim at adelsheiml@allegheny.edu or at 412-303-5309 or the faculty advisor for this project Dr. Sarah Conklin at sconklin@allegheny.edu or at 814-332-2392 or in her office in Carnegie 207.

Questions regarding participants rights or in the event of an injury please contact Ann Kleinschmidt, chair of the Institutional Review Board, at akleinsc@allegheny.edu or at 814-332-2366.

I am 18 years of age or older ___
(Participants under 18 years of age may not participate in this study)
I have read the above document and consent to participate in this study.

Name_____ Date_____

Signature_____

Appendix B: Demographics Survey

Age____

Sex:

a) Male
b) Female
c) Other

Ethnicity:

a) Caucasian
b) Black
c) Hispanic/Latino
d) Asian
e) Mixed
f) Other

How many caffeinated drinks do you consume on a typical day?

a) None- I don't regularly consume caffeine
b) 1-2 8oz cups
c) 3-4 8oz cups
d) 5-6 8oz cups
e) Over 7 8oz cups

Are you a smoker?

a) Yes
b) No
c) Former smoker

If so, how many cigarettes do you smoke on a typical day?

a) 1-4 cigarettes
b) 5-10 cigarettes
c) 10-15 cigarettes
d) 15-20 cigarettes
e) Over 20 cigarettes
f) I only smoke a few times a week, not every day

Do you exercise regularly?

a) Yes
b) No

If so, how many times per week do you exercise in a typical week?

a) 1-2 times a week
b) 3-4 times a week
c) 5-6 times a week
d) Every day of the week

How long do you typically spend exercising?

a) 20- 30 minutes
b) 30- 45 minutes
c) 45- 1 hour
d) 1 – 1.5 hours
e) 1.5- 2 hours
f) Over 2 hours

Appendix C: Debriefing Form

Debriefing Form

Perceived Socioeconomic Status in Childhood and Young Adult Cardiovascular Reactivity to Mental Stress

Thank you for participating in this study. The goal of this research is to investigate the relationship between a person's place in society growing up and how their cardiovascular system responds to stress, or cardiovascular reactivity. Abnormal reactivity can be a precursor to cardiovascular disease. Cardiovascular disease is the number one killer in the industrialized world however a number of the risk factors are still not well understood and it disproportionately impacts people from lower socioeconomic backgrounds.

We aim to see if the impact of childhood socioeconomic standing results in abnormal cardiovascular reactivity in young adults. Additional health information was collected to mask the aim of the study so participants wouldn't alter their response based on what they thought was expected. Thank you again for participating.

Contact Information: If you have any questions or would like a copy of the findings of this study please contact Lee Ann Adelsheim at adelsheiml@allegheny.edu or at 412-303-5309 or the faculty advisor for this project Dr. Sarah Conklin at sconklin@allegheny.edu or at 814-332-2392 or in her office in Carnegie 207.

Questions regarding participants rights or in the event of an injury please contact Ann Kleinschmidt, chair of the Institutional Review Board, at akleinsc@allegheny.edu or at 814-332-2366.

Additional Information:

Gruenewald, T. L., Karlamangla, A. S., Hu, P., Stein-Merkin, S., Crandall, C., Koretz, B., & Seeman, T. E. (2012). History of Socioeconomic Disadvantage and Allostatic Load in Later Life. *Social Science & Medicine (1982)*, *74*(1), 75–83. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3264490/

McEwen, B. S. (2007). Physiology and Neurobiology of Stress and Adaptation: Central Role of the Brain. *Physiological Reviews*, *87*(3), 873–904. http://physrev.physiology.org/content/87/3/873

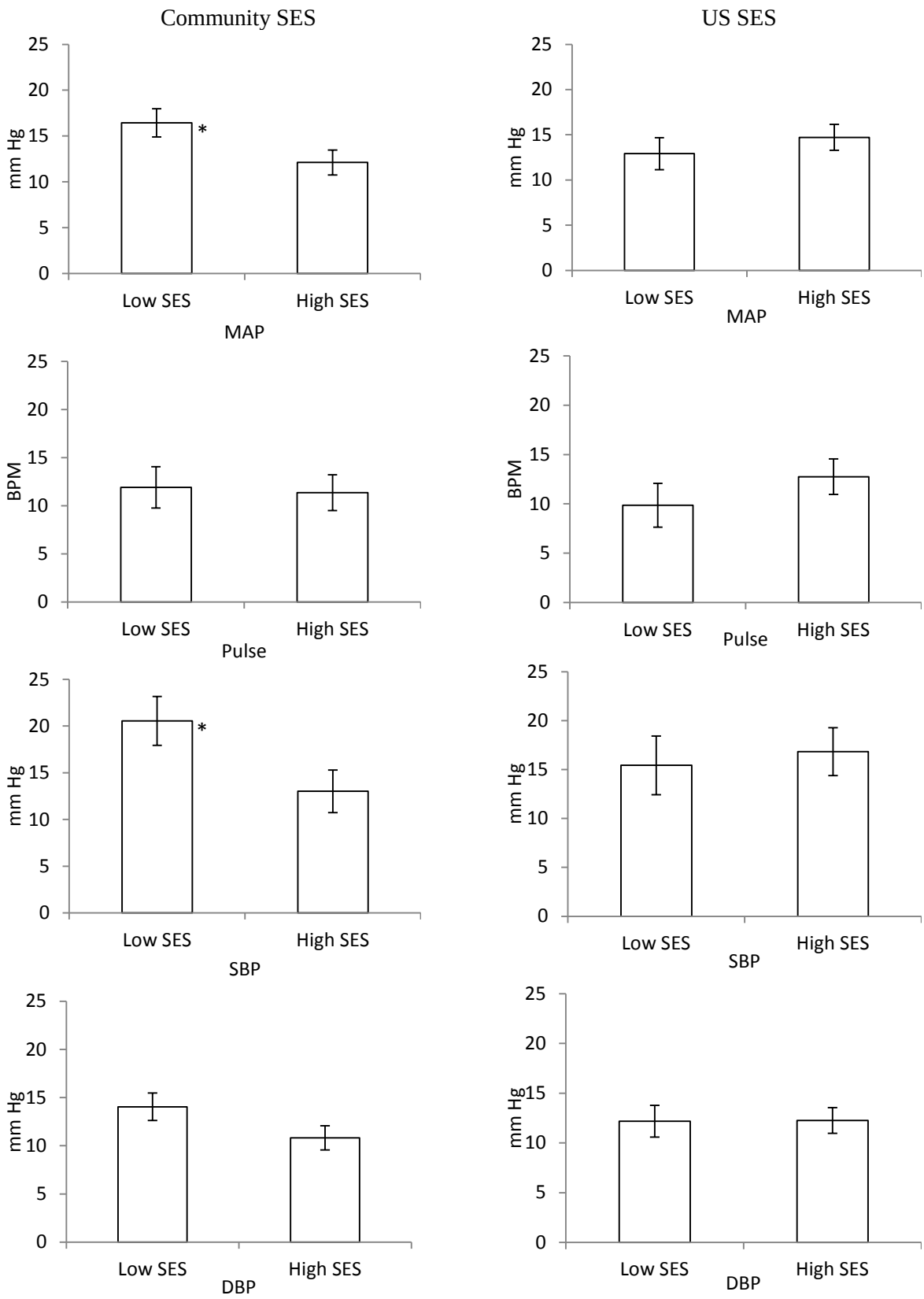

Figure 1. Reactivity means by SES groups. Notes: *p < 0.05. Mean (error bars show SE) of the reactivity for mean arterial pressure (MAP), pulse, systolic blood pressure (SBP), diastolic blood pressure (DBP) by high and low SES group for both the community and US MacArthur Scales.

Table 1 *Demographics and PASAT Phase Means by MacArthur Community and US Scales*

			MacArthur Scale for Community		MacArthur Scale for US	
		Whole Sample (n=30)	Low SES (n=13)	High SES (n=17)	Low SES (n=12)	High SES (n=18)
Age		19.67 (1.12)	19.62 (1.12)	19.71 (1.16)	19.58 (1.24)	19.72 (1.07)
Sex		60.0%	69.2%	52.9%	66.7%	55.6%
Race		83.3%	84.6%	82.4%	75.0%	88.9%
Non-smokers		93.3%	92.3%	94.1%	91.7%	94.4%
Childhood Neighborhood		66.7%	61.5%	70.6%	66.7%	66.7%
Baseline:	MAP	81.40 (6.54)	78.97 (6.84)	83.25 (5.84)	79.86 (7.27)	82.43 (6.00)
	Pulse	72.74 (11.04)	76.23 (12.66)	70.08 (9.13)	72.86 (10.77)	72.67 (11.53)
	SBP	110.82 (11.06)	106.18 (8.86)*	114.37 (11.49)	107.25 (11.12)	113.20 (10.66)
	DBP	64.24 (5.83)	62.41 (4.78)	65.65 (6.30)	63.75 (5.17)	64.57 (6.36)
Stress:	MAP	95.39 (8.47)	95.29 (10.78)	95.47 (6.55)	92.73 (10.36)	97.17 (6.68)
	Pulse	84.33 (13.59)	88.29 (16.31)	81.31 (10.61)	82.75 (12.18)	85.39 (14.69)
	SBP	127.09 (14.98)	126.23 (18.42)	127.75 (12.30)	122.32 (17.98)	130.28 (12.12)
	DBP	76.47 (7.08)	76.46 (7.38)	76.47 (7.06)	76.08 (7.98)	76.72 (6.63)
Recovery:	MAP	84.21 (7.00)	81.66 (7.65)	86.16 (5.96)	81.63 (8.28)	85.93 (5.59)
	Pulse	73.14 (11.15)	74.89 (14.56)	71.80 (7.87)	72.92 (9.48)	73.29 (12.40)
	SBP	112.14 (10.22)	108.89 (9.41)	114.62 (10.38)	108.63 (10.60)	114.48 (9.54)
	DBP	66.70 (5.57)	65.32 (5.83)	67.75 (5.30)	65.45 (5.94)	67.53 (5.32)

Notes: Sex is in percentage female. Race is the percentage who identified as white alone. Childhood neighborhood is the percentage from suburban neighborhoods. Mean Arterial Pressure (MAP), Systolic Blood Pressure (SBP) and Diastolic Blood Pressure (DBP) are all means in mm Hg. Pulse is a mean score in beats per minutes. *$p < 0.05$

Table 2
Post PASAT Survey Results by MacArthur Community and US Scales

	MacArthur Scale for Community		MacArthur Scale for US	
	Low SES (n= 13)	High SES (n= 17)	Low SES (n= 12)	High SES (n= 18)
PASAT Difficulty	3.62 (1.21)	4.00 (0.87)	4.00 (1.13)	3.72 (0.90)
PASAT Stressfulness	3.77 (1.24)	4.18 (1.07)	4.25 (1.29)	3.83 (1.04)
PASAT Perceived Performance	3.62 (1.19)	3.71 (0.99)	3.67 (1.07)	3.67 (1.09)
PASAT Engagement	4.31 (1.38)	4.47 (0.87)	4.67 (0.89)	4.22 (1.22)
Ability to Cope with PASAT Stress	4.15 (1.35)*	5.00 (0.15)	4.58 (1.38)	4.67 (0.84)
Incorrect Answers on PASAT	16.46 (17.80)	18.53 (17.45)	17.33 (18.93)	17.83 (16.73)
Skipped Answers on PASAT	23.08 (22.57)	27.00 (25.05)	28.08 (25.33)	23.44 (23.08)

Note: PASAT: Paced Auditory Serial Addition Task. Data is means of the response to Likert Scale post-task questions. *$p < 0.05$