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# Investigating the Role of Social Environmental Stress and Implicit Motives in Predicting Salivary Alpha-Amylase Reactivity to the Social Competence Interview

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## Abstract

Salivary alpha-amylase is emerging as a promising proxy for assessing sympathetic-adrenal-medullary (SAM) axis activity. However, it is not known whether a brief semi-structured behavioral assessment, such as the social competence interview (SCI), also elicits alpha-amylase changes. I hypothesized that (1) the SCI would elicit alpha amylase reactivity, (2) social environmental stress (i.e, high levels of exposure to violence during childhood and low perceived community social status) would predict the alpha-amylase response to the interview and (3) that agonistic striving would mediate the relationship between social environmental stress and amylase reactivity. The study sample was comprised of healthy young adults aged 18-24 recruited from a university research pool. Results showed that the social competence interview induced a significant alpha-amylase response ( $F(3, 60) = 15.3$   $p < 0.001$ ) which did not vary by sex ( $p > .05$ ). Furthermore, exposure to violence during childhood was positively associated with rise in alpha-amylase,  $r(60) = .28$ ,  $p = .03$ . However, agonistic striving did not mediate the relationship between exposure to violence and amylase reactivity. These findings provide further evidence for the utility of the social competence interview as a behavioral assessment eliciting sympathetic arousal and salivary alpha amylase as a sensitive index of stress reactivity. Moreover, the data bolster support for the hypothesis that greater exposure to social environmental stress during childhood may lead to potential negative health consequences in later life, for example, a more highly reactive SAM system.

Investigating the Role of Social Environmental Stress and Implicit Motives in Predicting  
Salivary Alpha-Amylase Reactivity to the Social Competence Interview

By

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B.A. Brandeis University, 2011

Master's Thesis

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## Investigating the Role of Social Environmental Stress and Implicit Motives in Predicting Salivary Alpha-Amylase Reactivity to the Social Competence Interview

A substantial body of research links lower objective socioeconomic status (SES), as measured by income, education, or occupation, to increased risk of both morbidity and mortality (Adams & White, 2004; Marmot, 2005). However, the pathways by which this association works remain poorly characterized. Traditional arguments to explain the gradient, such as decreased access to care, lower quality of care, or poor health behaviors, have failed to account for the large and pervasive differences in health outcomes (Andrulis, 1998; Smith, 1999). Findings that link health outcomes and SES are often confounded by the fact that one cannot separate the effect of real material resources associated with SES levels and subjective perceptions of higher status (Cohen et al., 2008). Indeed, a cluster of studies have demonstrated that lower-SES Mexican Americans report better health status and a lower all-cause mortality rate than non-Latino Whites and other ethnic groups of the same or even higher SES (Flack et al., 1995; Markides & Coreil, 1986; Patel, Eschbach, Ray, & Markides, 2004).

Concomitantly, epidemiological research over the past twenty years reveals an intriguing paradox—Latino newborns show more robust birth weight and lower mortality rates than infants of non-Latino white parents (Mathews & MacDorman, 2008), despite the often considerable disparity in socioeconomic background. In other words, evidence is accumulating that although the SES-health gradient follows a general linear pattern, higher SES does not necessarily predict better health, nor does lower SES necessarily portend poorer health. Instead, the gradient appears to be more influenced by several psychosocial factors (Adler, Epel, Castellazo & Ickovicks, 2000).



The purpose of this research project was to investigate two psychosocial constructs that are emerging as promising avenues for explaining the relationship between SES and health. One construct involves a person's subjective appraisal of his or her social standing in the community. The other construct involves subjective perceptions of environmental threats in the form of urban stress commonly associated with low SES.

### **Overview of the Present Study**

The present study aimed to investigate how the links between disadvantaged environments and poor health may be partially explained by two psychosocial mechanisms. One is an appraisal mechanism that involves subjective judgments concerning one's social status and personal vulnerability to environmental threats. The other is a motivational mechanism that involves persistent nonconscious striving to control one's social milieu. The proposed mechanisms of subjective appraisal and nonconscious motivation may undermine health by inducing and prolonging states of hypervigilance to social challenges. The present study advanced the hypothesis that subjective appraisals of self and environment combine with social control motives to predict acute sympathetic responses to social challenge, as indexed by changes in levels of saliva alpha-amylase. This hypothesis, suggested by Social Action Theory, implies that negative appraisals of one's social environment may contribute to exaggerated stress reactivity by motivating an ongoing struggle to anticipate and control interpersonal threats (Ewart et al., in press). Support for this model would suggest practical interventions to enhance health and prevent illness by altering interpersonal environments and facilitating health-protective strivings (Ewart, Elder, & Smyth, 2014).

In the introductory sections that follow, I review recent empirical findings that emphasize the importance of appraisal and motivational mechanisms in mediating the impact of social environments on psychological and physical health. I then consider evidence

suggesting that the impact of these mechanisms in fostering states of mental vigilance is reflected in acute sympathetic adrenal medullary responses to social challenge, indexed by a rise in the level of saliva alpha-amylase. I seek to explain how these findings form the basis for the study's main hypotheses.

### **Subjective Appraisals of Social Status and Exposure to Violence and Disorder**

Recent attempts to explain the link between social environments and health have highlighted the importance of subjective appraisals of social status and exposure to neighborhood violence and disorder. One promising candidate that might explain some of the variance in the SES-health gradient data is subjective social status (Adler & Stewart, 2007). Defined as how one perceives one's own socioeconomic status in relation to others, subjective social status is typically measured with two pictorial 10-rung ladders. In the first ladder, subjects are asked to rank where they think they stand, relative to others in their community (community social status); in the second ladder, subjects are asked to do the same task but compare themselves to others in their country or society in terms of money, education, and jobs (Adler & Stewart, 2007). In the past few decades, research has revealed subjective social status to be a reliable measure with adequate test-retest reliability of .62 (Operario, Adler, & Williams, 2004).

Subjective community social status has also proven to be a strong, independent predictor of various health indicators, including heightened stress responding indexed by changes in cortisol levels (Gruenewald, Kemeny, & Aziz, 2006). Indeed, subjective community social status may actually be a better predictor of health and health outcomes than more traditional objective measures of SES, such as income or education (Ghaed & Gallo, 2007; Singh-Manoux, Marmot & Adler, 2005). Numerous studies have shown consistent correlations between subjective community social status and health. Specifically, these

associations include: mood dysfunction (Leu et al., 2008); depressive symptoms (Goodman et al., 2001); daytime ambulatory diastolic blood pressure (Adler, Epel, Castellazzo, & Ickovics, 2000); diabetes, angina, depression (Singh-Manoux, Adler, & Marmot, 2003); susceptibility to the common cold (Cohen et al., 2008); and change in adiposity (Lemeshow et al., 2008). Not surprisingly, lower self-ranked community social status also predicts higher ratings of psychological distress (Sakurai, Kawakami, Yamaoka, Ishikawa, & Hashimoto, 2010) and worse self-rated health (Operario et al., 2004). Further research has shown that subjective community social status mediates the association between SES (defined by level of education) and long-standing illness or disability and diabetes, depression in men, and HDL-cholesterol in women (Demakakos, Nazroo, Breeze & Marmot, 2008).

A separate but similar correlate of detrimental health outcomes is a person's subjective appraisal of personal exposure to environmental threats, indexed by perceptions of neighborhood disorder or exposure to violence. A host of troubling indices such as noise pollution, litter, criminal activity, harassment by police, gang activity, graffiti, and substance abuse are characteristic of urban stress (Perkins & Taylor, 1996). Furthermore, neighborhood disorder has been linked to several health metrics, including poor self-rated health, increased emergency room visits, and increased total healthcare usage in a Canadian sample (Martin-Storey *et al.*, 2012). Perceptions of neighborhood disorder have also been linked to increased use of illicit substances among urban African-American men (Seth, Murray, Braxton, & DiClemente, 2012) and increased hypertension risk in urban adolescents (Ewart, Elder & Smyth, 2012) in the United States. Recent research also suggests that perceived neighborhood disorder may mediate the relationship between objectively measured neighborhood characteristics and poor health outcomes (Weden, Carpiano, & Robert, 2008).

Thus, two potentially separate appraisal constructs—perceived community social status and perceived exposure to neighborhood violence and disorder—appear to be robust mediators of the SES-health gradient. Whereas subjective community social status refers to appraisals of one’s status or influence relative to other people, perceived neighborhood disorder and violence refers to appraisals of the threatening aspects of one’s immediate physical surroundings. Nevertheless, both types of appraisals are similarly associated with the experience of chronic psychosocial stress. In persons who already face the harsh, stressful conditions that poverty entails, the addition of further insults (i.e., low self-perceived community social status, high perceived neighborhood violence and disorder) are likely to compound the deleterious effects of low SES on health.

### **Striving for Social Control**

A new approach to explaining the interplay between environment and health proposes that difficult social environments induce persistent motives or “strivings” that undermine health by chronically fostering hypervigilant psychological states (Ewart, Elder, & Smyth, 2014). Recent research suggests that perceived neighborhood disorder increases hypertension risk in adolescents by arousing stressful motives related to interpersonal control (Ewart, Elder, & Smyth, 2012). According to social action theory, an individual’s implicit social motives are important predictors of exposure to chronic psychosocial stress (Ewart & Jorgensen, 2004; Ewart et al., 2011). To assess a person’s implicit goals for managing persistent threats, the Social Competence Interview (SCI; described below), a standardized experiential narrative assessment protocol has been employed in several studies. Social motivational analyses conducted with the SCI in multi-ethnic samples of urban adolescents have found that the recurring, day-to-day stressors in this population (e.g., family stress, money stress, school stress) tend to generate stable, implicit motive dispositions, or “strivings”

(Ewart, 1994; Ewart & Jorgensen, 2004). Striving to control, manipulate, or impress *other* people typifies a pattern of implicit motives called agonistic striving, while striving to overcome a perceived personal defect, achieve an important personal goal, or engage in *self*-improvement characterizes a pattern called transcendence striving. Whereas agonistic strivers continually engage in a struggle to change or control others, with little regard for changing or controlling the self, transcendence strivers continually engage in a struggle to change the self, with little regard or interest in manipulating or controlling others. Thus, although both patterns are subjectively stressful, the key difference between the two lies in the focus: self versus other. A third, distressed pattern has also been identified; adolescents who fall into this group are characterized as dissipated strivers (DS). Rather than focusing on controlling or manipulating others, dissipated strivers lack any goal focus, exhibit low positive affect and wish that their problems would just disappear (Ewart, 2012).

Not surprisingly, many other features distinguish agonistic and dissipated strivers from transcendence strivers. Agonistic strivers are perceived by others as being more critical, aggressive, oppositional, and hypervigilant to threat during the SCI (Ewart, 2011). These adolescents also tend to have higher levels of ambulatory diastolic blood pressure over a 24-hour monitoring period relative to adolescents who do not exhibit agonistic striving, and also tend to exhibit more intense anger responses during an anger recall task (Ewart et al, 2011). This increased vascular reactivity is magnified in individuals who also have difficulty regulating their emotions (Ewart et al., 2011). Thus, one pathway to ill health may be via environmentally-induced agonistic striving—the agonistic subgroup seems particularly at high risk in terms of daily stress exposure and cardiovascular disease risk (Ewart, 2011).

However, the picture is not all grim. Transcendence strivers, who typically are focused on self-improvement, seem to enjoy a protective buffer from stress. During the SCI,

those who are rated to be high on transcendence striving are seen by raters as being friendly and cooperative. Furthermore, transcendence strivers are more likely to engage in positive, constructive problem solving than dissipated strivers, and also have the lowest levels of ambulatory blood pressure and highest levels of positive affect (Ewart & Jorgensen, 2004; Ewart, Jorgensen, Suchday, Chen, & Matthews, 2002). Thus, transcendence striving appears to represent a more health-protective motive profile.

Social action theory proposes that living in a disorderly or dangerous neighborhood increases stress levels by exacerbating the inability to satisfy social control motives that the environment provokes. For example, disordered and dangerous neighborhood conditions can make it difficult to ward off threats to self, friends, and family members, thus increasing the need to influence, manage, or control significant others in one's social network. Striving to control one's friends, family members, coworkers or neighbors, may then lead to increased stressful encounters on a daily basis, which then may foster coercive exchanges that harm one's health. Although arousal of the body's stress systems is beneficial in the short-term, repeated activations (i.e., due to repeated exposure to interpersonal stress) may damage the body in irreparable ways (Miller, Chen, & Cole, 2009; Sapolsky, 2005).

In the past decade, researchers have begun to examine how stressful environments and low social position can interact with implicit social motives to evoke hypervigilance and higher ambulatory blood pressure during daily activities (Ewart et al., 2002; Ewart & Jorgensen, 2004; Ewart et al., 2010). From this literature, a potential pathway emerges, linking stress exposure to poor health: agonistic striving, induced by stressful living conditions, seems to contribute greatly to worse health outcomes. Together, subjective appraisals of social environmental threats and agonistic striving for interpersonal control may explain how a stressful environment "gets under the skin" via activation of the human body's

stress systems. How these psychological mechanisms might affect stress physiology to undermine health is explained in the following sections.

### **Neuroendocrine Systems of Stress**

Subjective appraisals and agonistic motives are hypothesized to alter physiology by increasing alert mental vigilance to threat cues, which is associated with heightened readiness to take quick defensive action. The prototypical acute stress response, in which an injured prey is stalked and chased by its predator (as described by Sapolsky, Romero & Munck, 2000), is facilitated by a distinct neuroendocrine response combining two “waves” of psychobiological sequelae (Sapolsky, Romero, & Munck, 2000). During the first wave, the sympathetic adrenomedullary (SAM) system secretes the catecholamines adrenaline and noradrenaline; concurrently, a host of other hormones, including corticotrophin-releasing hormone (CRH), adrenocorticotrophic hormone (ACTH), and gonadotropin, are either secreted or suppressed by the HPA axis in order to aid the organism in dealing with the stressor (e.g., running away quickly and staying alive). The second wave is characterized by the slow and steady release of steroid hormones, including the glucocorticoid cortisol into the bloodstream, which generally enhances cardiovascular activation during stress (for a review, see Sapolsky, Romero & Munck, 2000).

The present analysis of appraisal and motivation mechanisms suggests that they may influence both waves of the stress response. However, the notion that subjective appraisals and agonistic motives foster hypervigilant mental states implies that they may be readily apparent in heightened first-wave SAM system activity to facilitate quick defensive or evasive action. Social challenges would be expected to induce increased SAM responding, especially in individuals who appraise their environments unsupportive or threatening, and who struggle to control others around them. The importance of SAM reactivity for indexing

states of hypervigilance is suggested by examining how the SAM and HPA systems differ, and the current state of our knowledge concerning each system's role in shaping the body's stress response.

### **Hypothalamic Pituitary Adrenocortical (HPA) axis**

The HPA axis is a neuroendocrine regulatory system that connects the central nervous system with the hormone system that helps an organism meet the demands of a stressful encounter and maintain homeostasis *after* the threat or challenge. Thus, cortisol secretion reaches a peak in blood at approximately 30 minutes after an acute stress experience (Lundberg, 2005). Many in the stress responsivity research field have focused on the role of cortisol in regulating and facilitating the so-called "second-wave" HPA stress response as well as the health outcomes that arise from either a hyperactive or a hypoactive HPA axis. For example, overactivity of the HPA axis is often found in major depression (Bjorntrop, 1996), susceptibility to infectious diseases (Mason, 1991), and cardiovascular problems (McEwen, 1998), whereas underactivity of the HPA axis is associated with illnesses such as multiple sclerosis (Adams & Victor, 1989), chronic fatigue syndrome, and rheumatoid arthritis (Tsigos and Chrousos, 2002). It is thus unsurprising that many researchers have worked to unravel the mechanisms of action by which the HPA system is linked to detrimental health outcomes, as it is relatively easy to gain an assessment of the HPA axis via saliva sampling, across the lifespan (Strahler et al., 2010).

### **Sympathetic adrenomedullary (SAM) system**

On the other hand, research conducted in the area of SAM activation, or the immediate "first-wave" response, is comparatively more limited and still emerging (Strahler et al., 2010). This is partially due to the fact that it is harder to assess the activity of the SAM system than it is to assess HPA axis activity. Generally, the release of the catecholamines



epinephrine and norepinephrine are considered standard markers of the SAM response. With the release of the catecholamines, a rapid cascade of cardiovascular and metabolic effects prepares the organism for immediate action (Axelrod & Reisine, 1984). However, to assess changes in catecholamines, it is necessary to take repeated blood samples from participants (i.e., before, during, and after a stressful encounter). On the other hand, to assess changes in the HPA axis, researchers consider taking salivary measures of cortisol to be sufficient.

**Salivary alpha-amylase.** Recently, salivary alpha-amylase, a key salivary enzyme that aids in the digestion of carbohydrates, has been evaluated as a promising proxy for assessing SAM activity, as it seems to be significantly associated with epinephrine and norepinephrine release after physical exercise (Chatterton, Vogelsong, Lu, Ellma, & Hudgens (1996) and is immediately responsive to acute psychosocial stress (Nater et al., 2006; Rohleder, Nater, Wolf, Ehlert & Kirschbaum 2004) in children, young adults, and older adults (Strahler, et al., 2010). Thus, evidence is accumulating that alpha-amylase can serve as an efficient and non-invasive marker of sympathetic activation. Indeed, alpha-amylase reactivity to stress is associated with increases in heart rate (Bosch et al., 2003) and decreases in heart rate variability. The ability to assess amylase via saliva sampling marks a considerable improvement upon previous research methodologies. Whereas there is an abundance of research on how socioeconomic and psychosocial factors impact the HPA axis stress response due to the relative ease of data collection methodology, research on how such factors affect the SAM axis reactivity to stress is relatively scant (Strahler et al., 2010). However, emerging research that basal as well as diurnal alpha-amylase levels may be elevated in patients with PTSD (Thoma et al., 2012) and patients with generalized social anxiety disorder (van Veen et al., 2008), two disorders that share a common denominator of hypervigilance and considerable anxiety.

## **Aims of the Present Study**

The present study aimed to investigate whether stressful environments associated with low perceived social status and high perceived neighborhood disorder undermine health by repeatedly arousing agonistic motives and activating an exaggerated SAM response to the Social Competence Interview. Specifically, the study tested the following hypotheses: (1) A challenging interview (SCI) that induces sustained attention to a persisting threat will evoke a significant rise in saliva amylase, indexed by the difference between the amylase levels recorded immediately before and after the SCI; (2) the magnitude of the change in saliva alpha-amylase during the SCI challenge will be negatively correlated with subjective appraisals of social status and positively correlated with perceived exposure to neighborhood violence and disorder; and (3) agonistic striving will mediate the relationship between social environmental stress (i.e., low subjective social status, high perceived neighborhood disorder and exposure to violence) and heightened SAM reactivity indexed by changes in amylase during the SCI.

## **Method**

### **Recruitment**

The study sample consisted of healthy young undergraduate students who were recruited via advertisements within an online research participation pool system at Syracuse University during the Fall of 2012 to Spring of 2013. All participants were enrolled in an introductory psychology course. Exclusionary criteria included: smoking status, autoimmune diseases, infectious diseases, thyroid diseases, cardiovascular diseases, and respiratory diseases, diseases of the airway, gastrointestinal tract, or urinary tract, mental illness, and allergies requiring regular medication. Participants also were excluded if their BMI was either lower than 18 or higher than 35, if they were diabetic, or if they had experienced

extraordinary stress in the preceding 6 months (e.g.: divorce, death of a loved one).

Participants who met these screening requirements were invited to take part in the 1.5 hour laboratory study, scheduled to begin between 2pm and 5pm to minimize time-of-day effects. As a token of appreciation for their time and effort, participants received course credit (1.5 SONA credits) at the end of the study. The Syracuse University Institutional Review Board approved all procedures.

Participants (n=104) ranged in age from 18 to 24 years with a mean of  $18.7 \pm 1.0$  years. Distribution of gender was relatively balanced, with 48 male and 56 female students electing to participate in the study. The racial composition of the sample was not equally distributed: 53.8% of the sample identified as White, 18.4% as Asian, 15.5% Black, 6.8% Other and 4.9% endorsed more than one race. Thus, the participant sample was relatively diverse, with 45.5% identifying their race as non-White and 54.5% identifying as White. Participants had a mean body mass index (BMI) of  $23.7 \pm 3.5$  kg/m<sup>2</sup> and a waist-hip ratio (WHR) of  $0.85 \pm .09$  which is within the healthy range for the age group present. Objective SES, defined as parental household income, was not normally distributed—median parental income was reported to be within the range between \$75,000 and \$99,999, but the income distribution was heavily bimodal, with approximately a quarter (27%) of students reporting total family income to be between \$0 and \$39,999 and approximately a quarter (24%) of students reporting total family income to be between \$200,000 and \$1,000,000 (See Figure 1). There were no significant gender or race differences in rank on the subjective community social status (C-SSS) or subjective socioeconomic status (US-SSS) ladders (all  $p > .05$ ).

## **Procedures**

After arriving at the laboratory, participants were invited to take a seat in a comfortable, well-lit receiving room in the Project Heart Suite at the Central New York Medical Center. A

trained experimenter explained all aspects of the study and obtained informed consent before proceeding with any of the experimental protocol. After written informed consent was obtained, basic demographic questionnaires were administered, including objective SES measures such as years of education, income level, mother and father's level of education and highest degree attained. Physiological data such as height, weight, body mass index (BMI), waist-hip ratio (WHR) were also assessed at the beginning of the session. After the 30-minute resting period, the first baseline (S0) amylase sample was taken and the participant was invited to rest quietly for another 10 minutes. After this 10-minute quiet resting period, participants were exposed to the social competence interview protocol (Ewart, Jorgensen, Suchday, Chen & Matthews, 2002). Further saliva samples were taken immediately before the SCI (S1), during the middle of the SCI (S2), and immediately after the SCI (S3), and 10 minutes after the SCI (S4). At the end of this period, participants were then thanked thoroughly, debriefed, and awarded course credit. The entire protocol lasted approximately 75 minutes. A timeline has been included in Appendix B.

### **Agonistic Striving**

**Social Competence Interview (SCI).** The SCI, a standardized laboratory stress interview (Ewart, Jorgensen, Suchday, Chen & Matthews, 2002), was used to elicit stress in our participants. The SCI is divided into two phases. During the first phase, the experimenter explains the purpose of the SCI and asks the participant to identify a particular area in his or her life in which they recently experienced stress (e.g., stress with peers, school, family, money, work, or neighborhood). The participant is then guided through a semi-structured interview in which they re-experience a specific stressful situation and describe the associated emotions and thoughts that accompanied the situation (e.g., how did that make you feel? What thoughts were going through your mind?) After this "hot" phase, the

experimenter then shifts focus to the second phase and asks the participant to imagine that they are a filmmaker making a movie about a character who is going through a similar experience. Then, the participant is asked to describe an ideal, but realistic ending for the character, and to describe the steps that they could take to make that ideal ending achievable. To conclude the interview, the participant is asked a series of questions about the plausibility of that ending occurring in real life and how confident they feel that they could bring about that ideal ending (Ewart, Jorgensen, Suchday, Chen & Matthews, 2002). An important issue to note about the SCI is that it is not intended to document stress chronicity, duration, or frequency. Instead, the SCI is used to identify the implicit motives and strivings that contribute directly to the experience of recurrent stress (Ewart & Suchday, 2002).

Following completion of the SCI, the interviewer immediately rated participants' level of agonistic striving on several Likert-type scales ranging from 0 (not at all) to 6 (very much). Trained graduate and undergraduate research assistants used the established behavioral coding system (See Ewart et al., 2002) to rate the goal-oriented strivings of the participants. Pearson coefficients of inter-rater reliability exceeded .85 on all scales.

**Agonistic goals.** As mentioned previously, agonistic striving refers to an individual's desire for controlling, manipulating or influencing others. To rate the participant's agonistic goal striving during the SCI, the experimenter completed three behavioral measures: Expressiveness (e.g., poise, emotional expressiveness, volume, detail of speech) Agonistic Self Defense (e.g., trying to stop hostile rumor, criticism, or to get even with someone) and Agonistic Affiliation (e.g., trying to seek someone's sympathetic support, affection, or understanding). The overall agonistic striving goal score was calculated by combining the two subscale scores. The internal consistency of this scale has been shown to be sufficient

(Ewart, Jorgensen, Suchday, Chen & Matthews, 2002) and previous research supports the temporal stability of this scale over a 3-month period (Ewart et al., 2002).

### **Subjective Appraisals of Social-Environmental Threats**

**Subjective Social Status.** The MacArthur Ladder of Subjective Social Status (1999) was used to assess perceived social status within the community and the United States (Adler & Stewart, 2007). To measure subjective Community Social Status (CSS), participants were presented with the following prompt: “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 the people who have the highest standing in their community. At the bottom are the people who have the lowest standing in their community. Where would you place yourself on this ladder?”

To measure subjective US Social Status (USSS), participants were also presented with the US socioeconomic status ladder, which includes a different prompt with more traditional objective SES primers with the following prompt: “Place an ‘X’ on the rung that best indicates where you stand in relation to others in the United States population in terms of income, education, and occupational prestige.”

**Perceived Exposure to Violence and Neighborhood Disorder.** To account for environmental stressors as another factor associated with poor health, the City Stress Inventory (CSI) will be used. The CSI contains two subscales: perceived Neighborhood Disorder (e.g., I saw people dealing drugs near my home in the past year) and Exposure to Violence (e.g., A family member or friend was robbed or mugged in the past year). The CSI has been shown to correlate with other indicators of social disadvantage and has adequate test-retest reliability (Ewart & Suchday, 2002). Since the study participants were expected to live in rather homogenous dormitories, they were asked to think of the neighborhood in

which they lived the longest, the neighborhood “in which [they] grew up,” prior to attending university.

### **Salivary Alpha-Amylase**

Participants were asked to gently chew on dental cotton rolls for one minute before placing the cotton rolls into sterile plastic tubes. Saliva samples were collected using the Salivette (Sarstedt, Newton, NC) collection system of dental cotton rolls and the samples were stored at room temperature until the end of the laboratory visit. Samples were then stored at -20°C until they were shipped for further analysis. During analysis, the Salivettes were centrifuged for 20 minutes at 2000g and 4°C. Salivary alpha-amylase activity was then measured via a commercially available assay kit (Salimetrics, State College, PA) using an enzyme kinetic method as described by Rohleder and Nater (2009).

### **Data Analytic Approach**

Statistical Analyses were performed using IBM SPSS Statistics 21 software package (IBM, Chicago, IL, USA). Analysis of variance (ANOVA) for repeated measures was computed to test for changes in salivary alpha-amylase concentrations at 5 time points: 10 minutes before, immediately before, during, immediately after and 10 min after the social competence interview. See Appendix B for timeline.

To test if the SCI induced a significant increase in amylase, a repeated measures ANOVA was computed using amylase levels at the expected baseline value (T0; 10 min before the SCI) were subtracted from the expected peak value (T2; immediately after the SCI) to form a delta amylase score. This “change in amylase” delta score was used as the amylase variable in bivariate Pearson correlations reported below. Repeated measures analysis of

variance (ANOVA) with two (T0, T2) within-group levels were computed for the salivary alpha-amylase response. Models also tested for possible sex differences.

To test if the magnitude of the change in amylase following the SCI was negatively correlated with participants' self-reported community social status and positively correlated with participants' self-reported neighborhood disorder or exposure to violence, bivariate Pearson Correlations were calculated.

To test whether agonistic striving mediates the relationship between community social status and delta amylase, bivariate correlations were calculated between the proposed predictor (community social status), mediator (agonistic striving), and outcome variables (delta amylase). A Sobel test was conducted using an SPSS macro (Preacher & Hayes, 2004) to confirm results. The criterion for statistical significance was  $p < .05$ , two-tailed.

## **Results**

### **Sample Characteristics**

The first 18 participants to enroll in the study (17% of the sample) comprised the pilot study, designed to test and perfect the protocol and therefore did not have complete datasets (i.e., they did not complete all study questionnaires and / or did not complete saliva sampling). Of the 84 remaining participants with complete datasets, sufficient funds were available to perform assays of salivary alpha-amylase for  $n=68$  randomly selected participants. Half of the sample ( $n=34$ ) was male and half was female. Participants ranged in age from 18 to 24 years with a mean of  $18.8 \pm 1.2$  years. Race was not equally distributed; 60% of participants identified as White, 16% as Asian, 12% as Black, 6% as Other and 6% endorsed more than one race.

### **Hypothesis 1: The SCI Challenge Increases Saliva Alpha-Amylase Levels**



The hypothesis that the SCI induces a significant increase in amylase was tested with a repeated measures ANOVA which compared differences in the levels of salivary alpha-amylase sampled at each collection point, from Time 0 (the baseline sample) to Time 3 (immediately after the SCI). As predicted, the level of alpha-amylase rose significantly between T0 and T3 [time effect:  $F(3, 60) = 15.3, p < 0.001$ ], with amylase concentrations at T3 ( $M = 114.7, SD = 89.2$ ) significantly different from Time 0 ( $M = 77.7, SD = 48.3$ ). The magnitude of this increase did not differ by sex ( $p < .05$ ). However, a one way ANOVA revealed that there was a significant sex difference with regard to the recovery of alpha-amylase after the interview, calculated as Time 4—10 minutes after interview, minus Time 3—immediately after the interview:  $F(1, 60) = 9.2, p = .004$ . Males exhibited a rapid decline in amylase back to baseline levels, and females exhibited a sustained elevation of amylase after the interview (See Figure 1).

### **Hypothesis 2: SCI-Induced Increases in Saliva Alpha-Amylase are Correlated with Subjective Appraisals of Social-Environmental Threats**

The hypothesis that the magnitude of the rise in amylase during the SCI is associated with subjective appraisals of the social environment was tested by examining Pearson correlations among the specified variables. Results revealed that the rise in amylase (T3-T0) was significantly correlated with perceived Exposure to Violence,  $r(60) = .28, p = .03$ . However, the rise in amylase was not significantly correlated with perceived Neighborhood Disorder, C-SSS, or US-SSS (all values of  $p < .05$ ).

### **Hypothesis 3: Agonistic Striving Mediates the Association between Subjective Appraisals of Environmental Threats and Saliva Alpha-Amylase Increases During the SCI**

The hypothesis that agonistic striving mediates the relationship between subjective appraisals of the social environment and alpha-amylase responses to stress was tested by performing regression analyses that regressed the change in alpha-amylase (Time 4 minus Time 0) separately on CSSS, US-SSS, EV, and ND. None of the predicted associations were statistically significant, and thus failed to support the mediation hypothesis (all values of  $p > .05$ ).

Despite the finding that Exposure to Violence (EV) was significantly associated with delta amylase,  $r(60) = .28$ ,  $p = .03$ , EV was not significantly with associated with Agonistic Striving (a path), and Agonistic Striving (AS) was not associated with delta amylase (b path). Furthermore, to confirm these findings and to rule out suppression, a Sobel test was conducted. The results of the Sobel test were not significant ( $p > .05$ ), confirming that agonistic striving did not play a mediating role.

Although mediation was not supported, I considered the possibility that agonistic striving may moderate the association between subjective appraisals of social environments and saliva alpha-amylase responses to the SCI. To examine this possibility, a test for moderation was conducted. The EV and AS variables were both centered, and an interaction term was created by multiplying the centered variables. A linear regression was conducted with both of the centered variables entered as the independent variable (IV) in the regression analysis on the first level, and the centered variables and the interaction variable as the IV's on the second level. Moderation was not supported.

## **Discussion**

The results of the study offer mixed support for its three main hypotheses. The first hypothesis was strongly supported; findings indicate that focusing attention on a persistent personal threat during the SCI evokes a large rise in saliva alpha-amylase, consistent with

rapid SAM responding. This study is the first to show that the SCI elicits a physiological sympathetic-adrenal-medullary response (SAM) axis response, as indexed by salivary alpha-amylase. Thus, in this sample of healthy young male and female college students, “reliving” a recent stressful experience via a semi-structured interview stimulated significant changes in salivary alpha-amylase, with mean peak amylase levels occurring at Time 2, immediately after the “hot” phase of the SCI. This response indicates that the SCI is a potent social stressor, and that its “experiential narrative” protocol may afford an ecologically valid method for investigating SAM reactivity to social-environmental threats.

The hypothesis that SCI-induced alpha-amylase responses are correlated with subjective appraisals of environmental threats received mixed support. As predicted, individuals who reported higher levels of perceived exposure to neighborhood violence exhibited greater amylase reactivity during the SCI. However, subjective appraisals of exposure to neighborhood disorder, as well as appraisals of one’s social status in the community (CSSS) or in the nation (US-SSS), were not correlated with alpha-amylase responses to the SCI.

Contrary to expectations, agonistic striving did not mediate the relationship between exposure to violence and change in alpha-amylase. One likely explanation for this finding is that the study population was relatively homogenous in terms of age, health status and education status. In this sample, few participants were rated as highly agonistic. Furthermore, the relatively small sample size discouraged the application of cluster analyses to form stress profiles (i.e., Agonistic, Transcendent, and Dissipated striving) from the stress narratives during the SCI, as has been done in previous studies with larger samples (e.g., Ewart & Jorgensen, 2004).

In sum, these data link perceived exposure to violence to increased amylase reactivity to an acute standardized lab stressor, offering a mechanism by which stressful social environments might “get under the skin” to produce poorer health outcomes later in life. Present findings add to the small but growing research literature linking alpha-amylase levels and responding to important health outcomes. For example, the diurnal salivary alpha-amylase activity has been shown to be higher in hypertensive older adults compared to normotensives (Strahler, Kirschbaum & Rohleder, 2011). Furthermore, the salivary alpha-amylase awakening response in war refugees with PTSD has been shown to be the opposite of healthy controls—rather than sharply declining after awakening, the PTSD patients showed a sharp increase in amylase (Thoma, Joksimovic, Kirschbaum, Wolf & Rohleder, 2012). In other research, sustained exposure to mutilation pictures promoted the greatest surge in amylase, as compared to neutral scenes, sports scenes, and erotica (Sanchez-Navarr et al., 2012). Taken together, the present findings and these emerging data indicate that the accumulative effect of exaggerated sympathetic arousal over time may pose serious health concerns—especially so for those who have been exposed to violence or sustained other adverse psychosocial interactions.

### **Limitations and Future Directions**

The chief limitations of the present study involve the use of a university student sample. Furthermore, the relatively small sample size warrants a cautious interpretation of the pattern of results. Given that the sample was an unusually healthy sample comprised of college students in an introductory psychology course, interpretation or generalization of the results to other populations should also be limited. For the current study, participants who endorsed any psychiatric, autoimmune, cardiovascular, gastrointestinal, or atopic diseases were excluded from participation. Likewise, participants who endorsed smoking or taking

any medications that would influence stress reactivity (e.g., stimulants, corticosteroids) were also excluded from participation. Thus, the resulting sample yielded a study population that was unusually hale. While this is a study strength in terms of reducing the variance or “noise” of the sample, it is also a crucial limitation. Future studies should strive to include a larger sample with increased variability in the health status of the participants in order to increase generalizability.

Indeed, researchers have already begun to examine diurnal amylase secretions in other populations and have reported that chronic stress is associated with alterations in the expected diurnal secretion pattern in caregivers for cancer patients (Rohleder et al., 2009) and in children with asthma experiencing challenging home situations (Wolf et al., 2008); unfortunately, the samples from these studies remain relatively small, and more research is needed to elucidate the relationships among chronic stress, amylase secretions, and indices of health. One potential avenue for new future research could be to investigate between-groups differences in amylase reactivity to stress. In the current study, different patterns seemed to emerge when comparing amylase reactivity across race (See Figure 3). Again, this preliminary finding should be interpreted cautiously as the samples are few.

In conclusion, the present study aimed to investigate the relationship between social environmental stress, implicit motives, and stress reactivity during the social competence interview. The social competence interview was shown to reliably elicit a sympathetic-adrenal-medullary (SAM) axis stress response, as indicated by repeated sampling of salivary alpha-amylase across time. Study results also indicated that higher levels of social environmental stress, i.e., exposure to violence during childhood, are associated with increased stress-induced alpha-amylase activity during late adolescence and early adulthood. These findings also contribute to the growing literature on the usefulness of salivary alpha-

amylase as a non-invasive and convenient method of assessing SAM activity. Future investigation into these preliminary findings is highly warranted.

Table 1  
*Means, Standard Deviations, and Pearson Correlations for All Study Variables*

	Mean (SD)	<i>r</i>					
		1.	2.	3.	4.	5.	6.
1. Subjective Social Status	6.1 (1.5)	1					
2. Exposure to Violence	1.4 (2.1)	.15	1				
3. Neighborhood Disorder	6.6 (6.1)	-.01	.56***	1			
4. Agonistic Striving	12.2 (5.0)	-.10	-.07	.02	1		
5. Rise in Amylase	41.0 (69.1)	.06	.28*	.10	-.03	1	
6. Recovery in Amylase	25.6 (54.4)	-.10	.13	.12	-.11	.09	1

Note. N=67.

\*\*\*  $p < .001$ . \*\*  $p < .01$ . \*  $p < .05$ .

Table 2  
*Means and Standard Deviations for Amylase and Cortisol Samples by Sex*

	Amylase (u/mL)		Cortisol (nmol/L)	
	Male	Female	Male	Female
Time 1	108.8 (61.5)	77.7 (48.3)	7.7 (4.5)	8.8 (4.4)
Time 2	108.3 (77.4)	79.7 (47.6)	6.8 (4.2)	8.1 (3.2)
Time 3	169.4 (122.4)	118.5 (77.1)	6.2 (3.8)	7.5 (3.4)
Time 4	156.8 (110.2)	114.7 (87.2)	6.4 (3.9)	7.4 (3.1)
Time 5	125.3 (99.9)	108.5 (72.8)	6.2 (3.9)	6.8 (3.5)

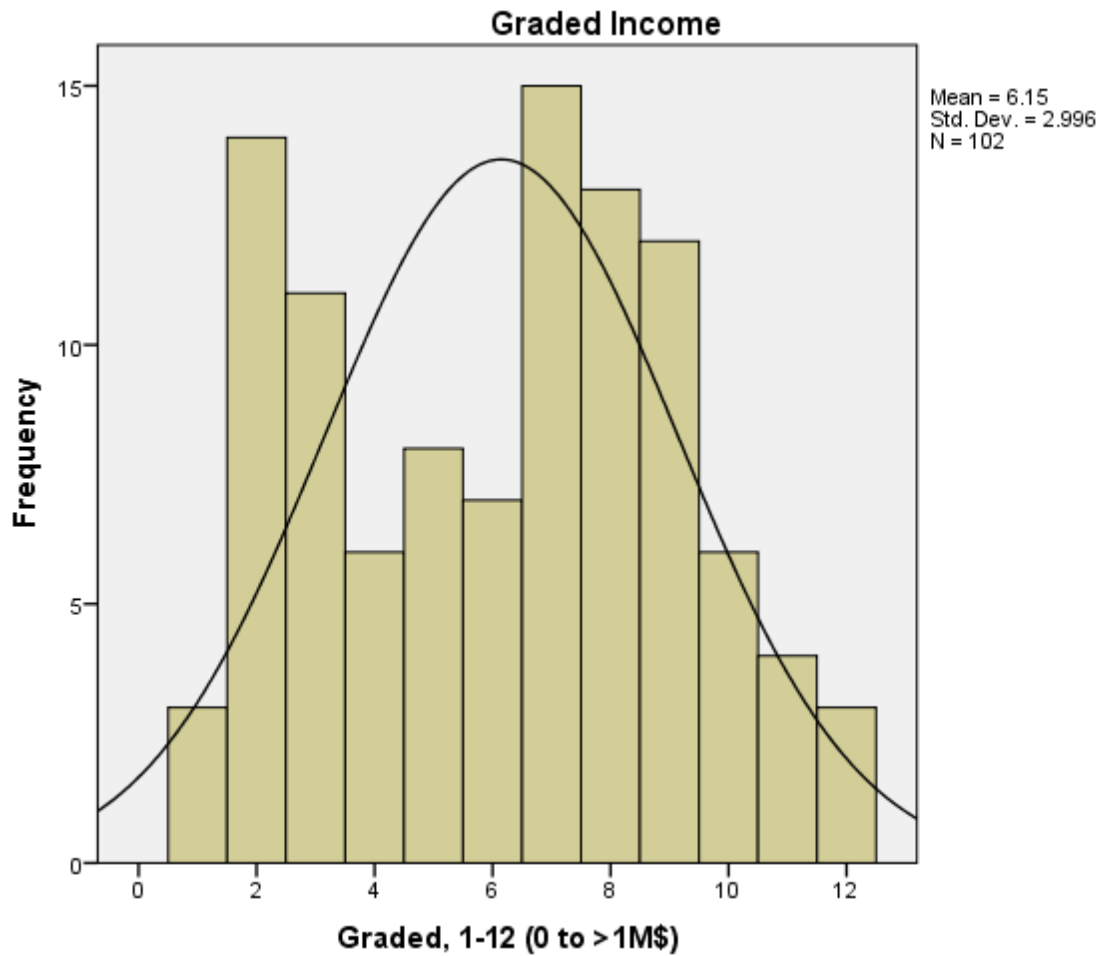
*Note.* N=67.



Table 3  
*Sociodemographic Statistics Stratified by Race*

Race (n)	Median Family Income (in USD)	Community Social Status (CSS)	City Stress Inventory (CSI)
Asian (18)	40,000-49,000	5.7 ± .36	8.37 ± 1.2
Black (16)	30,000-39,000	6.3 ± .24	15.1 ± 3.3
White (56)	200,000-299,999	6.1 ± .20	5.8 ± .61
Other (7)	75,000-99,000	6.8 ± .51	6.7 ± 2.7
More than 1 race (5)	75,000-99,000	6.9 ± .9	4.3 ± 2.5

Figure 1  
*Bimodal Distribution of Reported Family Income*



*Note.* 0 = Less than 0; 1=Less than \$9,999; 2= \$10,000-\$29,000; 3= \$30,000-\$39,999; 4= \$40,000-\$49,000; 5= \$50,000-\$74,999; 6= \$75,000-\$99,000; 7= \$100,000-\$149,000; 8= \$150,000-\$199,999; 9= \$200,000-\$299,999; 10= \$300,000-\$499,999; 11= \$500,000-\$999,999; 12 = \$1,000,000 or more;

Figure 2  
*Changes in Alpha-amylase across Time by Sex*

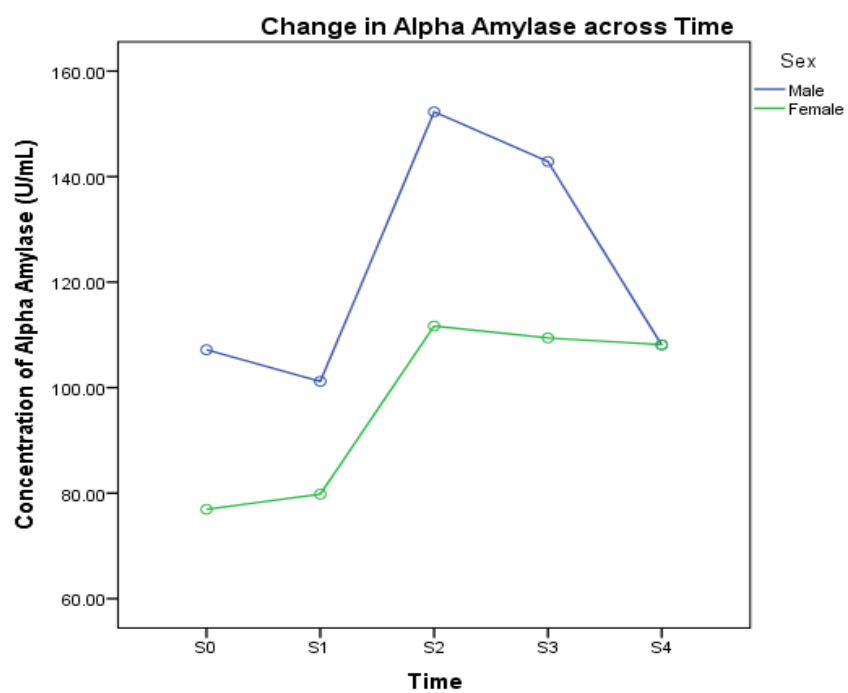


Figure 3: Changes in Alpha-amylase across Time by Race

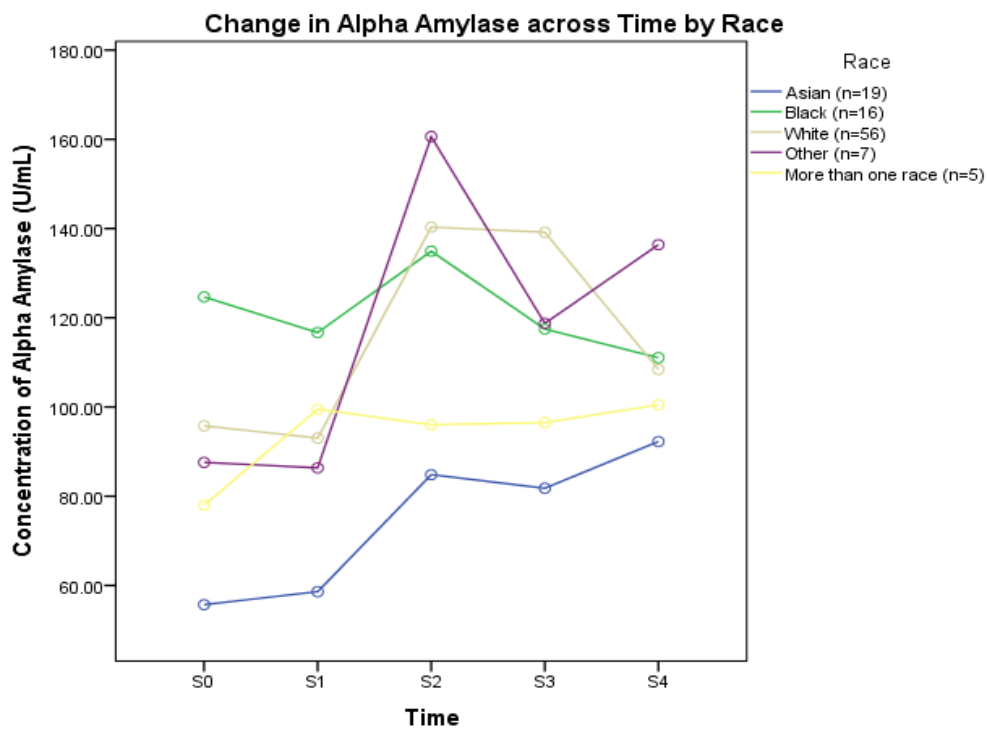
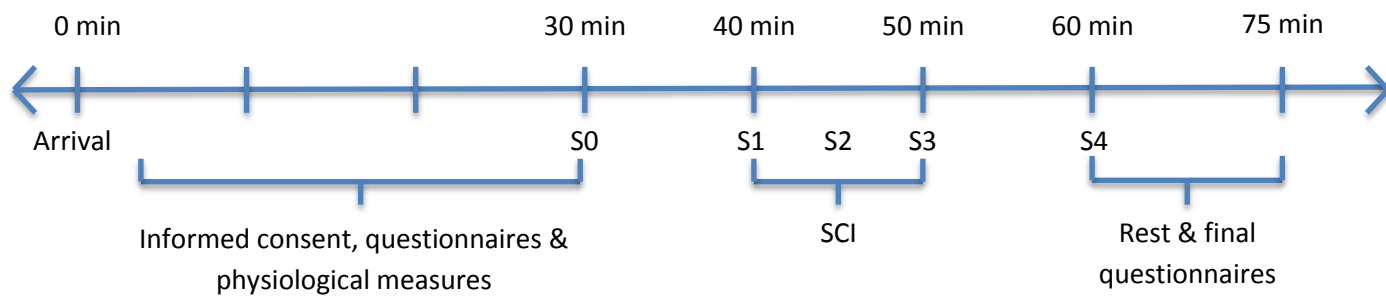


Figure 4: Timeline of Laboratory Visit



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