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**Individual Differences in Stress Physiology: Understanding Person by  
Situation Influences**

**by**

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## **Dedication**

To our sweet Violet:

May you always dream big and believe in yourself

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# **Individual Differences in Stress Physiology: Understanding Person by Situation Influences**

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Do person by situation effects influence physiological stress response? Despite being relatively uncontested since being theorized nearly 80 years ago, the fight-or-flight model of stress response has suffered criticism for its one-size-fits-all approach in light of the historical gender bias in the literature. In contrast, the tend-and-befriend model of stress response argues that females are driven to care for their offspring (tend) and band together with others (befriend) in response to stress. Despite evidence suggesting the importance individual differences in the effect of affiliation and social support on stress, past research has generally overlooked markers of individual difference and personality.

The major aim of this dissertation was to identify and examine potential person by situation effects on stress physiology, illuminating under what conditions and for whom affiliation and social support may buffer against the stress response and aid recovery in the wake of a stressor. Two studies were conducted to evaluate the role of individual

difference factors of gender and personality (i.e., person effects) and the availability of affiliation with a similar other (study 1) or a trusted friend (study 2) compared with no available affiliation (i.e., social situation effects) on stress response and recovery.

Study 1 revealed that availability of affiliation with a similar other did not have a protective influence on stress physiology in general. However, personality (openness to experience) and gender together, along with availability of affiliation, were important predictors of stress physiology over time. Study 2 indicated that the availability of affiliation with a trusted friend had a protective effect on stress physiology across each time point. Further, extraversion, conscientiousness, and openness to experience each appear to be important predictors of the influence of availability of affiliation with a close friend on stress physiology over time.

In sum, this dissertation found evidence of person by situation effects on stress physiology across two studies. In both studies, the effect of the availability of affiliation differed based on individual difference factors of personality, not on gender. As such, tend-and-befriend may be better conceptualized not as a uniquely female response, but rather a stress response that depends on individual difference characteristics of personality. Further, future stress response models and research should consider personality as an important marker of individual difference in physiological stress response.

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## INTRODUCTION

Stress is a quite prevalent experience for most, and can range from being momentary to unremitting. A stressor is broadly defined as any physical or psychological factor that causes a deviation from homeostasis (i.e., optimal physiologic balance). Stress is the resulting state of physiologic imbalance, and the goal of the stress response is to provide the resources necessary (e.g., increased blood pressure, oxygen-rich blood, increased blood glucose) to sustain the organism under threat, and eventually to return the body to homeostasis (McEwen & Lasley, 2002; Sapolsky, 2004b).

Cortisol (CORT), commonly called “the stress hormone” is a steroid hormone secreted by the cortex of the adrenal gland. Under normal conditions, CORT is responsible for regulating metabolic activities. In the face of a threat, however, CORT plays a significant role in the stress response by mobilizing energy, in the form of glucose to the bloodstream, needed to power muscles to combat or run from a threat. A hormonal cascade from the hypothalamus to the pituitary gland stimulates the cortex of the adrenal gland [referred to as the hypothalamic-pituitary-adrenal (HPA) axis] to release CORT in response to stress (Nelson, 2005; Sapolsky, 2004a)

The stress response is very effectively geared toward maintaining overall health in the face of acute stressors— relatively contained events that conclude after a brief duration (e.g., public speaking, physical challenge). However, the stress response begins to falter under conditions of chronic stress— when a stressor is recurring and/or unremitting over an extended period of time (e.g., abusive relationships, poverty, or

illness). In an attempt to better characterize both the acute and chronic cases of the stress process, McEwen & Stellar (1993) argued that the body adjusts optimal set points in various systems to compensate for imbalances in others, a process which they coined allostasis. Although the stress response is adaptive for coping in the short-term, the pathologic effects of repeated exposure to acute stress are numerous and morbid. Performing all of these allostatic functions to maintain overall balance comes at a cost, and the toll of the wear and tear that the adjustments and corrections take is termed allostatic load. Allostatic load overwhelmingly predicts negative health outcomes, and is thought to explain the mechanism behind many pervasive and costly stress-related illness such as hypertension, arteriosclerosis, cardiovascular disease, type-II diabetes, autoimmune disorders, depression, osteoporosis, among many others (McEwen & Lasley, 2002; Sapolsky, 2004a).

## **THEORIES OF STRESS RESPONSE**

The Fight-or-Flight model of acute stress response has been relatively uncontested since being theorized nearly 80 years ago. Heavily based on an animal literature studying male rats, fight-or-flight argues that we either aggress or flee in the face of an immediate threat, or stressor (Cannon, 1932). Although it is a convincing explanation for sympathetic nervous system (SNS) arousal observed in those experiencing acute stress (e.g., increased blood pressure and glucose to power large muscles), fight-or-flight has been criticized for its one-size-fits-all approach in light of the historical gender bias in the literature (Taylor et al., 2000).

### ***Going Beyond Fight-or-Flight***

Taylor and colleagues (2000) noted this bias and theorized the existence of a uniquely female biobehavioral stress response, which they coined tend-and-befriend. Given that fighting or outrunning an often stronger opponent might not prove the most adaptive stress response for a female, the tend-and-befriend model argues that females are biologically and behaviorally driven to care for their offspring (tend) and seek out and band together with other females in larger numbers (befriend) to protect themselves when threatened.

The theoretical contribution of tend-and-befriend as a uniquely female biobehavioral response to stress has yet to be empirically supported in the human literature, despite receiving much attention in the animal world. However, tend-and-befriend theory has served to underscore the importance of going beyond fight-or-flight and considering meaningful individual differences in the stress response that may be critical in better understanding stress-related disease risk and progression. Specifically, the tend-and-befriend model argues that affiliative social behaviors are critical to the stress-buffering model (Cohen & Wills, 1985), and may ward off stress-related disease by buffering against the deleterious effects of allostatic load (Taylor & Master, 2011).

The neuropeptide oxytocin (OT) is believed to be critical to the biological underpinnings of affiliative behaviors—both serving to promote social affiliation and increasing as a result of affiliation, as well as dampening HPA-axis response to stress (Taylor & Master, 2011). The majority of OT synthesis occurs centrally (inside the brain), with smaller concentrations made in the periphery (outside the brain), and is

known to be dependent on estrogen (Carter, 2007). While estrogen is a sex steroid hormone that is capable of traveling through the blood-brain barrier, OT itself is too large to pass through the blood-brain barrier in general, creating two essentially closed systems (van Honk, 2009). Furthermore, there is a tremendous distinction between OT actions in the periphery (e.g., milk letdown, labor) compared to centrally (e.g., bonding and affiliative behaviors), yet there is continued uncertainty as to the correlation between peripheral and central OT concentrations (Campbell, 2010). Contributing to this uncertainty is a host of methodological issues for researchers interested in humans, especially in understanding the role of OT in the stress response, due to the fact that measuring central OT concentration involves invasive and stress-inducing cerebrospinal fluid (CSF) sampling. Even with recent advances allowing exogenous OT to reach the brain via intranasal administration, researchers are still challenged by the need to measure central OT concentration and OT receptor binding and regulation to draw conclusions about the actions and localization of OT once administered (Campbell, 2010).

Given that these extensive methodological challenges have yet to be overcome, it appears that isolating and illuminating the influence of central OT on social behavior in humans is just out of reach pending new promising brain scanning methods (Campbell, 2010). Thus, herein I will focus not on the neural mechanisms underlying affiliative behavior, but on the affiliative behaviors themselves in response to stress.

This dissertation seeks to address the lack of empirical attention paid to the relationships of central yet understudied individual difference factors of gender and personality and their influence on acute stress response and recovery in the presence or

absence of affiliation and social support. Particularly, this dissertation aims to uncover under what conditions and for whom affiliation and social support may buffer against the stress response and aid recovery in the wake of a stressor. Beyond the individual contributions of gender, personality, and social support factors, the intersection of the three may offer insights into complicated individual differences in stress regulation and physiology.

## **INDIVIDUAL DIFFERENCES IN STRESS RESPONSE**

### **Affiliation, Social Support and Stress Response**

Affiliation was first studied by Schachter (1959) in which he informed pairs of participants that either one or both of them would receive an electric shock, then they were asked if they would like to be alone or have the company of the other participant. The results demonstrated that participants believing they would both be shocked were more likely to choose to affiliate with the other participant (e.g., a similar other), but this was not the case when they thought the other person would not receive a shock. This led Schachter (1959) to posit: “Misery does not just love any kind of company, it loves only miserable company.”

Affiliation seems to capture broadly the behavioral aspect of the tend-and-befriend model, and has been given considerable continued attention in the literature. Baumeister and Leary (1995) pointed to the importance of understanding affiliation, calling it a fundamental need, and there is an extensive literature demonstrating the role

of social support in buffering against the deleterious effects of stress, aptly called the buffering hypothesis (Cohen & McKay, 1984).

Although they overlap a great deal and are often used interchangeably, affiliation and social support have some important distinctions relevant to studies of stress response. Social affiliation, or affiliative behaviors more specifically, can be thought of as behaviors intended to provide social contact and bonding (Taylor & Master, 2011, p. 105). Social support, however, has been defined with a broader scope as the positive aspects or functions that social relationships provide (Uchino & Birmingham, 2011, p. 111; Uchino, Cacioppo, & Kiecolt-Glaser, 1996, p. 488). Further, the social support literature distinguishes between perceptions of support received by the target and actual support provided to the target—the effects of which appear to be somewhat independent (Cohen, 1988; Uchino & Birmingham, 2011). In particular, the features (e.g., quality and extent) of interactions intended to provide support and specific dimensions of received support (e.g., emotional versus tangible support) are understudied (Cohen, 1988), and appear important in order to untangle mixed findings of the effect of received support on stress (Bolger & Amarel, 2007; Uchino & Birmingham, 2011).

Given the extensive commonality, findings from stress research in both fields of study are highlighted and discussed here. For the current studies, *affiliation* will refer to availability of social contact with another individual, whereas the term *social support* will pay particular attention to the features (e.g., quality and extent) of social contact.

Social support literature has focused on the availability of a network of social support providers in general as a protective factor in warding off illness the aftermath of

stress (Cohen & Wills, 1985), yet comparatively few studies have examined the effects of affiliation and social support on acute stress response (e.g., Allen, Blascovich, & Mendes, 2002; Lepore, Allen, & Evans, 1993; Smith, Loving, Crockett, & Campbell, 2009; Uchino & Garvey, 1997) and the vast majority of this research has focused on cardiovascular measures of response to stress, ignoring the HPA-axis (Lepore, 1998; Thorsteinsson & James, 1999). Of the 22 studies reported in Thorsteinsson and James' (1999) meta-analysis investigating the availability of social support on laboratory acute stress, only two studies measured CORT levels (Kirschbaum, Klauer, Filipp, & Hellhammer, 1995; Thorsteinsson, James, & Gregg, 1998). However, human and non-human animal research has indicated that positive social interactions have been shown to greatly influence HPA-axis reactivity to acute stressors (DeVries, Glasper, & Detillion, 2003; Sapolsky, 2005).

Although affiliation has been studied in relation to stress and stress reactivity, there has been very little research examining affiliation in the wake of a stressor, the period of time immediately following the presentation of a stressor wherein the physiological arousal recovers to baseline (pre-stress) levels. Lepore et al. (1993), in one of the first studies to examine both men and women, had confederates offer social support to participants in anticipation of and during an acute stressor, with the results indicating that supportive contact reduces cardiovascular reactivity during a stressor compared with being alone or receiving non-supportive company. Further, they found that the presence of a confederate who did not offer support was related to increased cardiovascular stress reactivity.

Kirschbaum and colleagues (1995) studied the effect of affiliation on subsequent HPA-axis reactivity (as measured by CORT hormone concentration) to the Trier Social Stress Test (TSST; widely-used standardized laboratory social-evaluative stressor) by having participants affiliate either with their romantic partner, an opposite-sex stranger, or no one. The results indicated a gender difference whereby partner-supported men and stranger-supported women fared the best, showing the least overall Area Under the Curve (AUC; an average across all pre- and post-stress time points) CORT response, indicating a gender x support interaction whereby men benefited from their partners' presence but women did not. Interestingly, Kirschbaum et al. (1995) collected stress recovery data (up to 50 minutes post-stress salivary CORT levels), however they only analyzed peak response values and overall AUC response. This research evidences the continued neglect of the area of recovery from a stressor in general, and specifically with regard to testing potential affects of affiliation on recovery.

In a rare study that examined affiliation under both pre- and post-stress conditions (and actually reported the latter), Heinrichs et al. (2003) noted that social support from a participant's best friend prior to performing the TSST predicted lower HPA axis response to and better recovery at 60 minutes post-stress from the stressor, as well as lowest subjective anxiety ratings compared with participants receiving no social support. Participants who received no social support demonstrated elevated stress responses. This study highlights the importance of considering the effects of affiliation on both stress response and recovery. However, because the authors did not measure personality traits, questions regarding possible person by situation effects remain.

Jones and Josephs (2006) studied canines and their male handlers participating in a dog agility competition and found that after a loss, men were more likely to engage in punitive behaviors (e.g., yelling at, pushing dog), which predicted poor CORT recovery in their dogs. The authors did find that engaging in affiliative behaviors (e.g., petting, playing with dog), predicted better CORT recovery in their dogs after the loss. This study only looked at male handlers and their dogs, consequently the relationship of female handlers' behavior on dogs' CORT recovery is not known, and the effect of affiliation on CORT recovery in humans remains largely understudied.

### **Gender and Stress Response**

There is some evidence to suggest that salivary CORT response to acute stress may vary by gender under certain conditions, however there are no known studies that suggest a direct relationship. Particularly, gender, menstrual cycle and oral contraceptive use have each been shown to affect the amount of free (bioavailable unbound) CORT, however no differences in CORT concentration are evident in blood CORT concentrations (Kirschbaum, Kudielka, Gaab, Schommer, & Hellhammer, 1999). This finding suggests that differences in free salivary CORT concentrations are accounted for by circulating sex hormones, not the stress response itself.

Further, the gender-specific claims of tend-and-befriend that females are the ones engaging and benefiting from this response have not been well supported. Affiliation has been shown to benefit both sexes in reducing stress, though important gender differences in the effects of various kinds of relationships appear to exist. Specifically, men appear to

have lower acute stress responsivity when supported by their opposite-sex romantic partner compared to women, who actually show an increase in stress responsivity when supported by their partners (Kirschbaum, et al., 1995). However, participants in this study were provided with support during the anticipatory (pre-stress) stage, not in the wake of the stressor, thus it is impossible to extend these findings to recovery from a stressor. Beyond these examples, many studies have been confined to studying either males or females, offering little insight on the issue of a gender-specific stress response.

### **Personality and Stress Response**

The studies cited thus far have overlooked markers of individual difference and personality in their design, despite claims suggesting the importance individual differences in the effect of affiliation and social support on stress (e.g., Lepore, 1998). With the exception of use in screening out potential participants on the basis of psychopathology, trait-related anxiety measures, for example, are quite rare. None of these studies investigate characteristics of the individual much beyond self-report measures of subjective stress, state-related anxiety, and affectivity (e.g., Positive and Negative Affectivity Schedule; PANAS), which may be correlated with personality traits, but are not one and the same.

Considering the mixed and often contradictory evidence in the affiliation and stress literature, and the suggestion by tend-and-befriend theory of the importance of individual characteristics affecting stress response and recovery, it seems that including personality characteristics in these studies could help disentangle the speculative

relationships. It seems highly unlikely that tend-and-befriend is uniquely female stress response, given that men appear to respond favorably to affiliation and social support under stress in some cases (Aldwin, 2007). Perhaps gender is not the defining feature that explains who engages in and benefits from affiliation and social support under stress. Along these lines, Aldwin (2004) suggested that the fight-or-flight model should be amended to include “-or-affiliate” as a third possible response to stress (p. 262). I propose that, in order to understand the tend-and-befriend response to stress, we must look beyond strictly gender and examine the influence of personality characteristics.

The relationship between personality and stress physiology is believed to underlie vulnerability to stress, and a better understanding of this relationship may yield gains in our ability to identify those at greatest risk for costly and insidious stress-related illnesses (Uchino, Smith, Holt-Lunstead, Campo, & Reblin, 2007). The study of personality and stress has generally focused on the trait neuroticism. Higher scores on measures of neuroticism strongly predict perceived stress, and are related to greater reactivity to minor stressors. Essentially, people high on neuroticism are less emotionally stable, report more stress, are higher in negative affect, and are generally more reactive to stress when it occurs (Bolger & Schilling, 1991). The motivation to study this particular personality trait concurrently with stress is likely explained by the fact that, taken together, stress and neuroticism are powerful risk factors associated with depression and anxiety disorders (see Bolger & Schilling, 1991). Research also points to neuroticism beyond laboratory stressors, as higher N predicts greater acculturative stress in Mexican-American college students (Mangold, Veraza, Kinkler, & Kinney, 2007).

Together, these findings suggest a link between greater N and increased physiological stress response, which may lead to increased incidence of depression and other stress-related diseases. Specifically, this literature supports the prediction that individuals higher in neuroticism may experience greater physiological stress responses and demonstrate poorer physiological recovery from stress, with this potentially serving as a disease onset mechanism.

More recently, research has associated acute stress response with personality traits other than neuroticism. In particular, openness to experience has been linked to regulation of physiological stress response with higher openness leading to decreased, and as such, more adaptive cardiovascular stress response (Williams, Rau, Cribbet, & Gunn, 2009). In a study that measured HPA-axis reactivity, Oswald et al. (2006) found that participants high in openness demonstrated greater CORT stress responses than those low in openness, and they also uncovered a gender x personality interaction predicting CORT stress response whereby women high in N and men low in extraversion demonstrated blunted responses. Tyrka and colleagues (2007) recently demonstrated that individuals low in the trait Novelty-Seeking (i.e., high in behavioral inhibition) showed lower CORT responses to the TSST when compared with their high Novelty-Seeking peers.

Together, these findings paint a picture that the extent to which an individual is comfortable with or even pursues novel situations may be related to stress physiology in an important way. Further, it seems likely that the relationship between openness and stress physiology may uncover clues to explain recent findings linking greater openness

to decreased mortality rates among patients with coronary artery disease (Jonassaint et al., 2007). Specifically, the extent to which an individual is comfortable with novel experiences may represent a form of coping under stress, and as such greater openness to experience may be beneficially related to more adaptive stress regulation and perhaps greater use of available coping resources.

As one would expect based on the near absence of post-stress recovery data in the stress and affiliation literature, research incorporating stress and personality suffers from the same deficiency. Beyond linking greater neuroticism to poorer recovery in the wake of a stressor, research examining personality factors associated with recovery from a stressor acutely is severely lacking (Williams, Smith, Gunn, & Uchino, 2010). However, there is an extensive personality and coping literature, which is due in large part to the aforementioned links between personality and psychopathology.

### **Recovery from Acute Stress: Individual Differences in Coping**

As noted above, much of the stress literature has overlooked recovery from acute stress (i.e., CORT concentrations in the wake of the stressor and the extent to which they return from peak toward baseline levels) as an important outcome variable, concentrating on overall stress response (e.g., AUC CORT) or peak stress response. Although most studies have not collected post-stress data on stress recovery, findings of an influential meta-analysis indicated there are individual differences in the rates of recovery from acute stress (Dickerson & Kemeny, 2004). The vast majority of studies that did collect post-stress data did so in order to calculate overall stress response, choosing not to

analyze recovery from stress despite having the data necessary. Although coping is not synonymous with acute stress recovery, it can serve as a helpful analogue in the absence of relevant literature.

Many studies have linked personality characteristics with coping behaviors and coping effectiveness. McCrae and Costa (1986), for example, found that extroverts were more likely to seek social support from others and perform active coping strategies, while those high in N were more likely to engage in maladaptive coping, often coping passively (e.g., avoidance).

In their meta-analytic review of gender differences in coping, Tamres, Janicki and Helgeson (2002) report that neuroticism is higher among females across cultures, and the authors argue that this personality characteristic might explain the consistent finding that women employ more coping (and greater number of strategies) than men. Specifically, if women are more neurotic, then they are likely appraising more events as stressors than are men, and thus engaging in more coping overall as well as choosing more emotion-focused coping strategies.

## **SUMMARY**

Personality and individual differences seem to offer valuable insights into how a person responds both physiologically and subjectively to stress (e.g., neuroticism plays an important role in the evaluation of stressors) and thus, are important to consider when researching stress more broadly. Personality factors have seemingly been embraced by clinical and coping researchers, and have been able to elucidate previously unexplained

findings (e.g., neuroticism and gender differences in coping). Further, because personality traits represent characteristic ways of behaving, they may be valuable in understanding for whom social affiliation under conditions of stress is beneficial.

Based on the studies linking personality traits to the world of stress and coping, this dissertation aimed to incorporate these important variables into the empirical study of acute stress response and recovery. This dissertation seeks to fill the void discussed herein, and empirically examine the role of gender and personality characteristics on the effectiveness of affiliation and social support as a coping resource in response to and recovery from acute stress.

This dissertation argues for employing a person-by-situation approach to studying stress physiology, whereby personality characteristics and social affiliation may be useful in understanding important variation in stress response and recovery. Additionally, I hypothesize that tend-and-befriend may be a useful strategy for both men and women depending on personality characteristics, and thus may potentially be better conceptualized as an alternative biobehavioral response to stress—not a uniquely female one. Personality characteristics may offer promising explanations for social and physiological processes, such as recovery from acute stress, and further research is needed in this understudied domain.

Two studies were designed to better understand individual differences in stress physiology. Particularly, this research aims to illuminate the extent to which stress physiology is affected by the relationship between the individual difference factors of gender and personality and the availability of affiliation. In the case that the availability

of affiliation does affect stress physiology, a subsequent goal of this research is to identify which features of social support interactions (e.g., extent, quality) are important.

In the first study, we examined the role of affiliation with a similar other (i.e., also under stress) on stress physiology compared to being alone. We hypothesized that, depending on individual difference factors, the availability of affiliation with a similar other would yield beneficial effects to stress physiology (lower responsivity, greater recovery) compared to being alone.

In the second study, we extended this paradigm to examine stress physiology within the arguably more natural context of affiliation with a close friend (a person already in the social support network) compared to being alone. We hypothesized that the extent to which the availability of affiliation with a trusted friend influenced stress physiology compared to being alone would depend on individual difference characteristics. Further, we hypothesized that having a trusted friend available under conditions of stress would yield social support interactions that provide a buffering influence against the stressor.

The specific research questions of the current studies are outlined below.

## Overview of Research Questions and Studies

Taken together, the aim of the current studies was to address the following research questions:

1. Does social affiliation have a protective effect in physiological response to and recovery from acute stress?
  - a. Does the availability social affiliation with a similar other have a protective effect on stress physiology compared to being alone?
  - b. Does the availability social affiliation with a trusted friend have a protective effect on stress physiology compared to being alone?
2. For whom is the availability of affiliation with a similar other or a trusted friend beneficial? Are person by situation effects on stress physiology evident?
  - a. Does gender matter? Are women more likely to benefit from affiliation, as tend-and-befriend theory would suggest?
  - b. Does personality matter? Are some people more likely to benefit from affiliation based on individual difference characteristics?
  - c. Does the effect of affiliation on stress physiology depend on both gender and personality?
3. Under conditions when social affiliation with a similar other or a trusted friend is available, to what extent do people engage in social behavior with others in the wake of a stressor?

- a. Does the extent of social behaviors vary depending on personality or gender?
  - b. Does language use vary depending on personality or gender?
4. Under conditions when social affiliation with a similar other or a trusted friend is available, which features of social support behavior are related to physiological recovery from acute stress?
  - a. Which components of social support behavior such as the quality, intimacy or extent of social support during dyadic affiliative interaction are related to physiological stress recovery?
  - b. Which components of language use during dyadic affiliative interaction are related to physiological stress recovery?

For this dissertation, I conducted two studies to address the above research questions, and along with them, the void of research examining the role of affiliation, gender, and personality on not only stress response, but also recovery from stress.

Study 1 sought to compare acute stress response to and recovery from a standardized laboratory stressor whereby both men and women were assigned to room alone (solo condition,  $n = 42$ ) or in the presence of a same-sex similar other (i.e., another participant; affiliation condition,  $n = 49$ ) during the experiment. Participants completed a personality questionnaire to measure individual differences before completing the stressful task, and provided four salivary CORT samples at 20-minute intervals (2 pre-stress, 2 post-stress) throughout the study to provide the outcome measures. A subset of

participants ( $n = 24$ ) within the affiliation condition were video recorded for approximately 15 minutes immediately following the stressor to assess the extent and quality of interaction between these same-sex dyads. Data collection for study 1 was carried out from December 2006 to April 2008.

Study 2 was designed to extend the same experimental paradigm to compare acute stress response and recovery of participants roomed alone (solo condition,  $n = 48$ ) or in the presence of a trusted same-sex friend (i.e., instead of a fellow participant; affiliation condition,  $n = 36$ ). As previously stated, this study sought to better address an arguably more natural approach to affiliation, in that people under stress may be more likely to engage in affiliative behaviors with and/or receive more support from close friends than strangers who are merely similar others. Data collection for study 2 was carried out from October 2008 to April 2010.

## METHODS

### Study 1

#### PARTICIPANTS

Ninety-one students enrolled in an introductory psychology course at The University of Texas at Austin participated to receive credit for a course research requirement (see Table 1 for demographic information). Participants included in the study were not taking antidepressants, stimulants, or steroid hormones at the time of testing. Only participants without endocrine disorders were included. Included participants had refrained from heavy exercise on the day of the experiment, and had not smoked cigarettes or had anything to eat or drink besides water for the hour prior. This study took approximately one hour and 30 minutes to complete.

Table 1. *Study 1 demographic characteristics did not significantly differ by study condition (solo vs. affiliation group).*

|                                     | <b>Solo<br/>(n=42)</b> | <b>Affiliation<br/>(n=49)</b> | <b>Test statistic (df)</b> |
|-------------------------------------|------------------------|-------------------------------|----------------------------|
| <b>Age (mean years, and SD)</b>     | 19.10 (1.25)           | 19.04 (1.04)                  | t (89) = 0.227             |
| <b>Gender (M/F)</b>                 | 55% / 45%              | 51% / 49%                     | $\chi^2$ (1) = 0.13        |
| <b>Ethnicity (Hispanic / Other)</b> | 26% / 74%              | 16% / 84%                     | $\chi^2$ (1) = 1.33        |
| <b>Race (Caucasian / Other)</b>     | 48% / 52%              | 49% / 51%                     | $\chi^2$ (1) = 0.02        |

Note: †  $p < .10$ , \*  $p < .05$ , \*\*  $p < .01$ .

## **MEASURES**

### ***Hormone Assays***

Salivary CORT was collected four times from each participant across the study at 20-minute intervals. Saliva samples approximately 3mL in volume were obtained by passive drool into a plastic 15mL collection tube, and the samples were immediately stored in a freezer upon collection. The concentrations were analyzed in-house with commercially available Assay Designs (Plymouth Meeting, PA, USA) enzyme immunoassay kits. Saliva samples were completely thawed, then centrifuged for 10 minutes at 3000 rpm immediately prior to assay. All CORT samples were assayed in duplicate, and the intra-assay coefficient of variance (CV) was within the acceptable tolerance for CORT (under 15% CV). The inter-assay CV of the high and low control samples averaged together was also within the tolerance for CORT (under 15% CV).

### ***Hormone Data Analyses***

As is routine with hormone data, all raw CORT concentrations (measured in pg/mL) were log-transformed to achieve normality (see Appendix E for reproductions of all figures using raw CORT as the dependent variable instead of log-transformed CORT). CORT data from six participants were excluded due to extreme hormone concentration values (extremely low or high). After excluding these six participants, the total number of included participants is 85 (n=42 solo condition, n=43 affiliation available condition). Demographic characteristics of the study sample did not differ by condition (as noted in table 1), and this remained true regardless of the inclusion/exclusion extreme hormone data from these six participants.

CORT responsivity to acute stress was examined utilizing multilevel modeling for repeated measures analyses to provide a better estimate of error variance across repeated measurements, with time 2 (pre-stress at 40 minutes elapsed time), time 3 (post-stress at 60 minutes elapsed time) and time 4 (post-stress at 80 minutes elapsed time) taken together as the dependent variable, controlling for time 1 (baseline pre-stress at 20 minutes elapsed time).

### ***Modified Trier Social Stress Test***

This study employed a modified version of the Trier Social Stress Test (TSST; Kirschbaum, Pirke, & Hellhammer, 1993), which is used frequently to induce moderate levels of stress and increases in CORT, blood pressure, and heart rate. The current version involved having participant prepare a speech and then deliver the speech to a judge and video camera, and omitted the mental arithmetic task that follows the speech in the full version (see Appendix A for modified TSST materials). A meta-analysis revealed that laboratory stress paradigms involving uncontrollability and social-evaluative threat (e.g., public speaking task with judging, videotaping), as the TSST does, elicited the most reliable and robust stress responses (Dickerson & Kemeny, 2004).

The procedure began with the experimenter taking the participant to another room, where a confederate judge (another experimenter) wearing a white lab coat sat next to a video camera with a clipboard. The experimenter then explained that the participant was to give a speech defending themselves from a hypothetical allegation of theft to the judge, a trained behavior analyst, and a video camera. They were also told that the speech would be videotaped for later analysis. The experimenter explained that the

researchers were interested in the level of convincingness and creativity of the argument, and their verbal and non-verbal behavior, which would be analyzed and compared to other participants. Next, participants were told that they would be given a prompt detailing the allegation of theft, and they would be given five minutes to prepare their speech, after which time they would be brought back to deliver their speech.

Participants were then returned to their room, given the speech prompt, and told their preparation time had begun. After five minutes elapsed, participants were brought back to the judging room to deliver their speech. The judge maintained a neutral facial expression, and only spoke if the participant stopped speaking. If the participant was silent for more than 10 seconds, the judge delivered prompts from a set list to keep the participant speaking such as, “You still have more time—please continue.” Once five minutes had elapsed on the judge’s stopwatch, the participant was stopped and told, “Your time is up. Please return to you room now.” If a participant appeared to have an adverse reaction to the stressor, the experiment was discontinued immediately, and the participant was thoroughly debriefed. In all, this modified TSST took about 12 minutes to complete.

### ***Self-Report Questionnaires***

Questionnaires administered in this study are listed according to whether they were given pre- or post-test (i.e., pre- or post-TSST), and are further separated by category.

#### Pre-Test:

Background Questionnaire. Non-published, brief questionnaire designed to assess demographic information, and potential factors that could influence physiological response to stress. Includes questions on prescription drugs and medical problems that are exclusionary.

State-Trait Anxiety Inventory (STAI; Spielberger, Gorsuch, & Lushene, 1970). Published measure of situational, state-related anxiety levels as well as stable, trait-related anxiety levels. The State Anxiety portion was administered pre-test. The Trait Anxiety portion was administered post-test.

Big Five Inventory (BFI; John, Donahue, & Kentle, 1991). The BFI is a widely used 44-item measure of self-descriptive statements, measuring the Big Five factors of personality; Neuroticism, Extraversion, Openness to Experience, Agreeableness, and Conscientiousness.

#### Post-Test:

Affiliation Questionnaire. Non-published, 5-item brief questionnaire developed by the researchers to assess participants' feelings about affiliating with other participants.

State-Trait Anxiety Inventory (STAI; Spielberger, et al., 1970). Published measure of situational, state-related anxiety levels as well as stable, trait-related anxiety levels. The State Anxiety portion was administered pre-test. The Trait Anxiety portion was administered post-test.

#### ***Affiliative Behavioral Coding***

A subset of participants ( $n = 24$ ) assigned to the affiliation condition (paired into same-sex dyad with another participant also completing the TSST, and shared same room

throughout experiment) were video recorded for approximately 15 minutes in the time between physiological sample 2 and 3, immediately after the TSST. A small digital video camera placed in the corner of the room was turned on while the experimenter was completing the time 2 physiological measurement, and turned off when the experimenter returned to collect the time 3 sample.

In reviewing the interactions, seven aspects of participants' affiliative behaviors were identified and measured:

1. Ratio of Time Speaking: Because recording times differ, we calculated the ratio of length of time speaking (time in minutes and seconds that the participant of interest spent speaking) to total recording time (the time of the recording in minutes and seconds from the time the experimenter leaves the room, to the time the experimenter returns).
2. Number of conversations attempted: The number of times the participant of interest speaks to or looks at the other participant in the room.
3. Number of conversations successful: The number of attempted conversations that result in a returned utterance from the other participant in the room. The percentage of attempted conversations that are successful indicates the level of acceptance/rejection of the participant of interest (i.e., when the percentage of successful conversations is low, this indicates more rejection).
4. Extent of interaction: A one through seven scale that rates the amount or extent of the interaction on the part of the participant of interest. Possible Ratings: 1= no interaction whatsoever, 2= very minimal interaction (barely any), 3= minor

- interaction, 4= moderate interaction (about half the time spent interacting), 5= major interaction, 6= very major (nearly constant) interaction, to 7= extreme (constant) interaction.
5. Quality of interaction: A one through seven scale that rates the quality of the interaction (i.e., pleasant/enjoyable versus irritating/angering) on the part of the participant of interest. Possible Ratings: 1= extremely negative, 2= moderately negative, 3= slightly negative, 4 = neutral experience, 5= slightly positive, 6= moderately positive to 7= extremely positive.
  6. Intimacy of interaction: A one through seven scale that rates the intimacy of the interaction (i.e., extent of personal disclosure, discussion of personal topics) on the part of the participant of interest. Possible Ratings: 1= not personal whatsoever, 2= very minimally personal (barely), 3= minor personal interaction (somewhat) , 4= moderate personal interaction (about half the time spent interacting talking about personal things), 5= major personal interaction, 6= very major (nearly constant) personal interaction, to 7= extremely (constant) personal interaction.
  7. Stressor-relevant conversations: Participants' discussion of stressor-related topics was examined in each conversation and coded as being stressor-related or not. Those conversations deemed to be stressor-related were then broken down in to two subgroups, evaluative versus factual, which were then tallied for each individual participant. Examples of a stress-related and evaluative statement would include, "I was so nervous", or "I found the speech difficult". Examples of

a stress-related and factual statement would include, “I prepared a speech then gave it”, or “The judge took notes”. Conversations were coded as not stress-related in the case that they did not discuss the stressor or the participants’ feeling about the stressor. For example, conversations that included “I like living in Austin”, or “Who is your 301 professor?” would be coded as not stress-related. In total this yielded three variables of interest: (1) number of stressor-relevant conversions, (2) number of stressor-evaluative conversations, (3) number of stressor-factual conversations.

Alphas for each of the three coded behavior variables of extent of interaction ( $\alpha = .90$ ), quality of interaction ( $\alpha = .79$ ), and intimacy of interaction ( $\alpha = .86$ ) were sufficiently high and suggested a high degree of agreement between coders.

### ***Language Use Analyses***

Linguistic Inquiry Word Count (LIWC; Pennebaker, Chung, Ireland, Gonzales, & Booth, 2007). Transcripts of the post-stress video recordings of affiliation condition participants were analyzed using LIWC, a word count program designed to measure language use in an emotional setting by classifying word use into language, and psychological categories (Slatcher, 2009). Of particular relevance, personal pronoun use, emotion word use (positive and negative), and assents have been shown in past research to reflect important characteristics of social interactions such as motivation to affiliate, relationship satisfaction, and cohesion, respectively (Slatcher, 2009; Tausczik & Pennebaker, 2010). Thus, in this study, in addition to overall word count, we measured usage of the personal pronouns “I”, “we” (we, us, our), and “you” (you, your), positive

emotion words (e.g., happy), negative emotion words (e.g., sad), and assents (e.g., agree, yes) during post-stress dyadic interactions.

## **PROCEDURE**

Participants volunteered for a session of the study starting between 2:00 pm and 4:00 pm using an online subject pool appointment system. Upon arrival at the lab, participants were asked to rinse their mouths with water (to remove food particles). After confirming the participant was at least 18 years of age and had not consumed food or beverages other than water in the past hour, informed consent was obtained (see Appendix B for study timeline). Participants were randomly assigned to either the solo (roomed alone) or affiliation condition (roomed with another participant in same sex-dyad). Participants were roomed according to condition, then spent 20 minutes resting quietly and completing the initial questionnaire packet (Background Questionnaire, BFI, and the STAI-Trait). If they completed the questionnaires before the 20 minutes was up, they were asked to sit quietly and wait. Participants were then asked to provide the first of four physiological measurements (time 1; CORT levels represent pre-stress baseline at 20 minutes elapsed time) collected at 20-minute intervals throughout the study. Each physiological measurement included a 3mL saliva sample, blood pressure and heart rate as measured three consecutive times using a digital cardiovascular monitor. If they had not finished their questionnaire packet in the 20 minutes allotted, participants were asked to finish any remaining non-state dependent questionnaires during their next 20-minute interval between physiological measure collections.

Once participants had provided the first saliva sample, they were given the instructions for the TSST and started the task. After completing the TSST, participants returned to their room where they provided the time 2 physiological measurement (CORT levels represent anticipatory stress), and completed the STAI-State. At this point, a subset of 24 participants in the affiliation condition were videotaped to record any post-TSST interaction between the members of same-sex dyads. There were no requirements of them to interact at all, and no instructions were given, as we were interested in examining naturalistic behavior in the wake of a stressor. Twenty minutes later, participants provided the time 3 physiological measurement (CORT levels represent peak stress response), at which time the camera was turned off in the affiliation condition. After the final 20-minute interval had elapsed, participants provided the time 4 physiological measurement (CORT levels represent recovery from stressor), and completed the Affiliation Questionnaire.

Upon completion of the study, participants were debriefed regarding the true purpose of the task (i.e., to elicit a stress response), and asked to sign a post-hoc consent form if they agreed include their data (100% of participants agreed). The Internal Review Board at The University of Texas at Austin approved all study procedures.

## Study 2

### PARTICIPANTS

Eighty-four students enrolled in an introductory psychology course at The University of Texas at Austin participated to receive credit for a course research requirement (see Table 2 for demographic information). Participants included in the study were not taking antidepressants, stimulants, or steroid hormones at the time of testing. Only participants without endocrine disorders were included. This study took approximately one hour and 30 minutes to complete.

Table 2. *Study 2 demographic characteristics did not significantly differ by study condition (solo vs. affiliation group).*

|                                     | <b>Solo<br/>(n=48)</b> | <b>Affiliation<br/>(n=36)</b> | <b>Test statistic (df)</b> |
|-------------------------------------|------------------------|-------------------------------|----------------------------|
| <b>Age (mean years, and SD)</b>     | 18.56 (0.74)           | 18.50 (0.85)                  | t (82) = -0.360            |
| <b>Gender (M/F)</b>                 | 44% / 56%              | 39% / 61%                     | $\chi^2$ (1) = 0.20        |
| <b>Ethnicity (Hispanic / Other)</b> | 27% / 73%              | 44% / 56%                     | $\chi^2$ (1) = 2.74†       |
| <b>Race (Caucasian / Other)</b>     | 29% / 71%              | 42% / 58%                     | $\chi^2$ (1) = 1.42        |

Note: †  $p < .10$ , \*  $p < .05$ , \*\*  $p < .01$ .

## **MEASURES**

### ***Hormone Assays***

Salivary CORT samples were collected in the same intervals and using the same procedures as study 1. However, the concentrations in this study were analyzed in-house with commercially available Salimetrics (State College, PA, USA) enzyme immunoassay kits (not Assay Designs as in study 1). As in study 1, saliva samples were completely thawed, then centrifuged for 10 minutes at 3000 rpm immediately prior to assay. All CORT samples were assayed in duplicate, and the intra-assay coefficient of variance (CV) was within the acceptable tolerance for CORT (under 15% CV). The inter-assay CV of the high and low control samples averaged together was also within the tolerance for CORT (under 15% CV).

### ***Hormone Data Analyses***

As is routine with hormone data, all raw CORT concentrations (measured in ug/dL) were log-transformed to achieve normality (see Appendix E for reproductions of all figures using raw CORT as the dependent variable instead of log-transformed CORT). CORT data from five participants were excluded due to extreme hormone concentration values (extremely low or high). After excluding these five participants, the total number of included participants is 79 (n=43 solo condition, n=36 affiliation available condition). Demographic characteristics of the study sample did not differ by condition (as noted in table 2), and this remained true regardless of the inclusion/exclusion extreme hormone data from these five participants.

CORT responsivity to acute stress was examined utilizing multilevel modeling for repeated measures analyses to provide a better estimate of error variance across repeated measurements, with time 2 (pre-stress at 40 minutes elapsed time), time 3 (post-stress at 60 minutes elapsed time) and time 4 (post-stress at 80 minutes elapsed time) taken together as the dependent variable, controlling for time 1 (baseline pre-stress at 20 minutes elapsed time).

### ***Modified Trier Social Stress Test***

See study 1 for detailed explanation.

### ***Self-Report Questionnaires***

See study 1 for questionnaires administered.

### ***Affiliative Behavioral Coding***

All participants assigned to the affiliation condition in study 2 ( $n = 36$ ) were video recorded for approximately 15 minutes in the time between physiological measurements at time 2 and time 3, immediately after the TSST. The affiliative behavior of the participant and their same-sex friend were recorded and coded using the same coding scheme as in study 1 (see full description in study 1 methods).

Alphas for each of the three coded variables of participant behavior of extent of interaction ( $\alpha = .83$ ), quality of interaction ( $\alpha = .68$ ) and intimacy of interaction ( $\alpha = .66$ ), as well as participant friend behavior of extent of interaction ( $\alpha = .83$ ), quality of interaction ( $\alpha = .69$ ), and intimacy of interaction ( $\alpha = .70$ ) were sufficient and suggested a moderate to high degree of agreement between coders.

### ***Language Use Analyses***

Linguistic Inquiry Word Count (LIWC; Pennebaker, et al., 2007). As in study 1, in addition to overall word count, we measured usage of the personal pronouns “I”, “we” (we, us, our), and “you” (you, your), positive emotion words (e.g., happy), negative emotion words (e.g., sad), and assents (e.g., agree, yes). See study 1 for further explanation.

Linguistic Style Matching (LSM; Niederhoffer & Pennebaker, 2002). LSM is a dyad-level measure of the level of engagement in a social interaction and reflects the extent to which people use function words (nine categories: personal pronouns, impersonal pronouns, articles, conjunctions, prepositions, auxiliary verbs, high-frequency adverbs, negations, and quantifiers) similarly (Ireland et al., 2011). LSM appears to gauge the “interpersonal coordination of psychological states” (Ireland & Pennebaker, 2010, p. 549). In addition to the individual-level LIWC measures of language use listed above, LSM was employed in study 2 to attempt to assess level of engagement and coordination in each dyad. LSM is calculated for each of the nine categories of function words using this formula (example below calculates LSM score for “preps” or prepositions):

$$LSM_{preps} = 1 - [(|preps1 - preps2|) / (preps1 + preps2 + 0.0001)]$$

Using the above formula, a score is calculated for each of the nine function words categories individually, then all nine scores averaged to create the overall LSM score for each dyad. LSM scores range from 0 (no matching) to 1 (perfect matching), whereby higher scores indicated greater dyad-level coordination or engagement in an interaction.

## **PROCEDURE**

The experimental procedures for study 2 were the same as study 1, with one major exception—the affiliation condition. The key departure from the previous study is that participants in the affiliation condition were roomed with a trusted friend who accompanied them to the study session and stayed in the room with them during the experiment, instead of sharing a room with another participant whom they did not know (as in study 1).

Specifically, all participants were instructed to bring a trusted, platonic, same-sex friend with them to the experiment. Participants in the affiliation condition were roomed with the friend who had accompanied them to the experiment; no identifying information was collected from participants' friends, and informed consent was not needed for those individuals. Participants in the solo condition were told that due to a scheduling change their friend would not be required to stay and sit through the study after all, and that they were free to go. In the solo condition, 100% of participants agreed to continue with the experiment without their friend. This arrangement ensured that all participants had a trusted same-sex friend available to accompany them, and did not differ characteristically.

## **RESULTS**

### **Study 1**

#### **DESCRIPTIVE ANALYSES**

In this section, descriptive statistics for the self-report and CORT hormone measures from this study are presented. Subsequently, analyses that individually address the specific research questions posed herein are presented.

First, descriptive information comparing measures of personality, anxiety, and CORT by condition (solo versus similar other affiliation available) for all 85 included participants (n=42 solo, n=43 affiliation) was examined (Table 3). As noted in the methods section, all CORT concentrations have been log-transformed to achieve normality. Mean scores and variances did not significantly differ on any of these measures of personality, anxiety, or CORT by condition (regardless of the inclusion/exclusion of the six participants with extreme hormone data).

Next, descriptive information comparing measures of personality, anxiety, and CORT by participant gender (n=39 women, n=46 men) was assessed (Table 4). Mean scores and variances did not significantly differ on any of these measures by gender, with the exception of BFI Neuroticism and STAI State Anxiety. Women demonstrated significantly higher mean neuroticism scores compared to men, while men reported significantly higher mean state-level anxiety after the stressor.

Table 3. *Study 1 self-report and hormone measures by condition (solo vs. similar-other affiliation).*

|                              | <b>Solo (n=42)</b><br><b>Mean (SD)</b> | <b>Affiliation (n=43)</b><br><b>Mean (SD)</b> | <b>t-value (n)</b> |
|------------------------------|----------------------------------------|-----------------------------------------------|--------------------|
| <b>CORT</b>                  |                                        |                                               |                    |
| <b>T1 Pre-stress 20 min</b>  | 6.86 (0.64)                            | 6.96 (0.47)                                   | t (83) = -0.843    |
| <b>T2 Pre-stress 40 min</b>  | 6.98 (0.65)                            | 6.93 (0.61)                                   | t (83) = 0.329     |
| <b>T3 Post-stress 60 min</b> | 6.97 (0.62)                            | 7.03 (0.67)                                   | t (83) = -0.400    |
| <b>T4 Post-stress 80 min</b> | 6.78 (0.61)                            | 6.87 (0.66)                                   | t (83) = -0.677    |
| <b>BFI</b>                   |                                        |                                               |                    |
| <b>Extroversion</b>          | 25.9 (7.27)                            | 26.0 (7.01)                                   | t (83) = -0.077    |
| <b>Agreeableness</b>         | 34.5 (5.32)                            | 35.1 (5.21)                                   | t (83) = -0.561    |
| <b>Conscientiousness</b>     | 30.9 (5.17)                            | 31.0 (6.34)                                   | t (82) = -0.078    |
| <b>Neuroticism</b>           | 22.4 (6.13)                            | 20.8 (6.19)                                   | t (83) = 1.208     |
| <b>Openness</b>              | 36.2 (5.45)                            | 37.2 (5.39)                                   | t (83) = -0.837    |
| <b>STAI</b>                  |                                        |                                               |                    |
| <b>Trait-level Anxiety</b>   | 26.2 (4.37)                            | 24.9 (5.09)                                   | t (73) = 1.203     |
| <b>State-level Anxiety</b>   | 20.8 (5.11)                            | 20.3 (5.64)                                   | t (78) = 0.434     |

Note: †  $p < .10$ , \*  $p < .05$ , \*\*  $p < .01$ .

Table 4. Study 1 self-report and hormone measures by gender.

|                              | <b>Women (n=39)</b><br><b>Mean (SD)</b> | <b>Men (n=46)</b><br><b>Mean (SD)</b> | <b>t-value (n)</b> |
|------------------------------|-----------------------------------------|---------------------------------------|--------------------|
| <b>CORT</b>                  |                                         |                                       |                    |
| <b>T1 Pre-stress 20 min</b>  | 6.97 (0.53)                             | 6.86 (0.59)                           | t (83) = 0.911     |
| <b>T2 Pre-stress 40 min</b>  | 6.94 (0.55)                             | 6.97 (0.69)                           | t (83) = -0.188    |
| <b>T3 Post-stress 60 min</b> | 6.94 (0.66)                             | 7.04 (0.64)                           | t (83) = -0.699    |
| <b>T4 Post-stress 80 min</b> | 6.80 (0.68)                             | 6.85 (0.60)                           | t (83) = -0.347    |
| <b>BFI</b>                   |                                         |                                       |                    |
| <b>Extroversion</b>          | 24.9 (7.16)                             | 26.8 (7.01)                           | t (83) = -1.193    |
| <b>Agreeableness</b>         | 35.4 (4.89)                             | 34.2 (5.52)                           | t (83) = 1.608     |
| <b>Conscientiousness</b>     | 31.5 (6.30)                             | 30.4 (5.30)                           | t (82) = 0.848     |
| <b>Neuroticism</b>           | 22.9 (6.26)                             | 20.5 (5.95)                           | t (83) = 1.827†    |
| <b>Openness</b>              | 36.4 (5.15)                             | 37.0 (5.67)                           | t (83) = -0.453    |
| <b>STAI</b>                  |                                         |                                       |                    |
| <b>Trait-level Anxiety</b>   | 24.9 (4.36)                             | 26.0 (5.12)                           | t (73) = -0.979    |
| <b>State-level Anxiety</b>   | 18.9 (5.03)                             | 22.0 (5.25)                           | t (78) = -2.692**  |

Note: †  $p < .10$ , \*  $p < .05$ , \*\*  $p < .01$ .

Next, the relationships between the Big Five personality traits and CORT were assessed. Correlations between each personality trait and each CORT sample are reported in Table 5 both for the entire sample and within participant gender (n=39 women, n=46 men). Overall, aspects of personality were significantly correlated with CORT at each time point. In particular, CORT at time 1 was marginally positively correlated with both neuroticism and openness to experience. CORT levels during time 2 (pre-stress), time 3 (post-stress, 60 minutes elapsed) and time 4 (post-stress, 80 minutes elapsed) were all negatively correlated with extraversion.

Among women, neuroticism was marginally positively correlated with CORT during time 2 and time 3, while conscientiousness was negatively correlated with CORT levels during time 2 and time 3. No significant correlations emerged between personality and baseline or recovery CORT levels.

Within men, openness to experience was significantly negatively correlated to CORT levels during baseline, anticipatory stress, and recovery time points. Extraversion was significantly negatively correlated with peak and recovery CORT levels.

As expected, CORT levels among each time point were highly positively correlated both across the sample overall and within gender. Personality traits were relatively uncorrelated to one another with the exception of neuroticism, which was significantly negatively correlated with extraversion, agreeableness, and conscientiousness. Also, conscientiousness was positively correlated with agreeableness. No significant correlations were present between CORT levels at any time point and self-reported state anxiety or trait anxiety.

Table 5. Study 1 CORT hormone by personality correlations by gender.

|                   | <b>T1</b> | <b>T2</b> | <b>T3</b> | <b>T4</b> | <b>Ext</b> | <b>Agr</b> | <b>Cons</b> | <b>Neur</b> |
|-------------------|-----------|-----------|-----------|-----------|------------|------------|-------------|-------------|
| <i>Overall</i>    |           |           |           |           |            |            |             |             |
| <i>(n=85)</i>     |           |           |           |           |            |            |             |             |
| <b>CORT T2</b>    | .69**     |           |           |           |            |            |             |             |
| <b>CORT T3</b>    | .59**     | .86**     |           |           |            |            |             |             |
| <b>CORT T4</b>    | .62**     | .79**     | .82**     |           |            |            |             |             |
| <b>BFI Ext</b>    | -.17      | -.19†     | -.22*     | -.21†     |            |            |             |             |
| <b>BFI Agr</b>    | .01       | .06       | .01       | .04       | .11        |            |             |             |
| <b>BFI Con</b>    | -.09      | -.12      | -.16      | -.12      | .19†       | .33**      |             |             |
| <b>BFI Neur</b>   | .19†      | .09       | .14       | .11       | -.36**     | -.41**     | -.22*       |             |
| <b>BFI Open</b>   | .19†      | .13       | .01       | .10       | .13        | -.06       | -.16        | -.13        |
| <i>Women Only</i> |           |           |           |           |            |            |             |             |
| <i>(n=39)</i>     |           |           |           |           |            |            |             |             |
| <b>CORT T2</b>    | .58**     |           |           |           |            |            |             |             |
| <b>CORT T3</b>    | .55**     | .86**     |           |           |            |            |             |             |
| <b>CORT T4</b>    | .53**     | .72**     | .80**     |           |            |            |             |             |
| <b>BFI Ext</b>    | -.14      | -.26      | -.21      | -.14      |            |            |             |             |
| <b>BFI Agr</b>    | -.05      | -.01      | -.19      | -.10      | .22        |            |             |             |
| <b>BFI Con</b>    | -.09      | -.27†     | -.37**    | -.16      | .15        | .41**      |             |             |
| <b>BFI Neur</b>   | .22       | .28†      | .30†      | .24       | -.21       | -.61**     | -.28†       |             |
| <b>BFI Open</b>   | -.01      | -.13      | -.15      | -.15      | .16        | .01        | .04         | -.11        |
| <i>Men Only</i>   |           |           |           |           |            |            |             |             |
| <i>(n=46)</i>     |           |           |           |           |            |            |             |             |
| <b>CORT T2</b>    | .76**     |           |           |           |            |            |             |             |
| <b>CORT T3</b>    | .64**     | .88**     |           |           |            |            |             |             |
| <b>CORT T4</b>    | .72**     | .86**     | .87**     |           |            |            |             |             |
| <b>BFI Ext</b>    | -.17      | -.15      | -.25†     | -.29*     |            |            |             |             |
| <b>BFI Agr</b>    | .03       | .10       | .18       | .17       | .06        |            |             |             |
| <b>BFI Con</b>    | -.12      | -.01      | .06       | -.07      | .26†       | .24        |             |             |
| <b>BFI Neur</b>   | .14       | -.02      | .02       | .01       | -.46**     | -.31*      | -.20        |             |
| <b>BFI Open</b>   | .34*      | .29†      | .13       | .31*      | .10        | -.10       | -.32*       | -.14        |

Note: †  $p < .10$ , \*  $p < .05$ , \*\*  $p < .01$ .

## RESEARCH QUESTION RESULTS

### **Question 1A: Does the availability social affiliation with a similar other have a protective effect on stress physiology compared to being alone?**

As noted in the descriptive results, mean CORT levels at each time point did not differ significantly by condition (see Table 3). Further, multilevel modeling revealed that availability of affiliation did not appear offer a protective effect on stress physiology.

To assess the effect of the availability of affiliation on stress physiology over time using repeated measures of participants, a multilevel model with random intercepts was employed. Specifically, CORT levels across time 2 (pre-stress, 40 minutes elapsed), 3 (post-stress, 60 minutes elapsed), and 4 (post-stress 80 minutes elapsed) were the CORT response outcome variable, and CORT at time 1 (pre-stress baseline) was included as a covariate to control for baseline CORT level. To test whether there was an effect of availability of affiliation on overall stress physiology over time, study condition (solo vs. affiliation available) was included as a predictor along with time (both linear and quadratic; to reflect change over time 2, 3, and 4), and the interaction of condition x time. The interaction of condition x time controlling for baseline CORT was a marginally significant predictor of CORT response [ $F(1,167) = 2.912, p = .09$ ] along with the underlying main effects and the main effect of quadratic time, while quadratic time did not significantly interact with condition [ $F(1,166) = 0.205, p = .65$ ; Table 6]. This finding suggests that trajectories of CORT levels across time differed based on whether affiliation with a similar other was available, with the solo condition appearing to

demonstrate somewhat lower time 1 (baseline) and time 4 levels (80 minutes elapsed) than their affiliation condition counterparts (Figure 1).

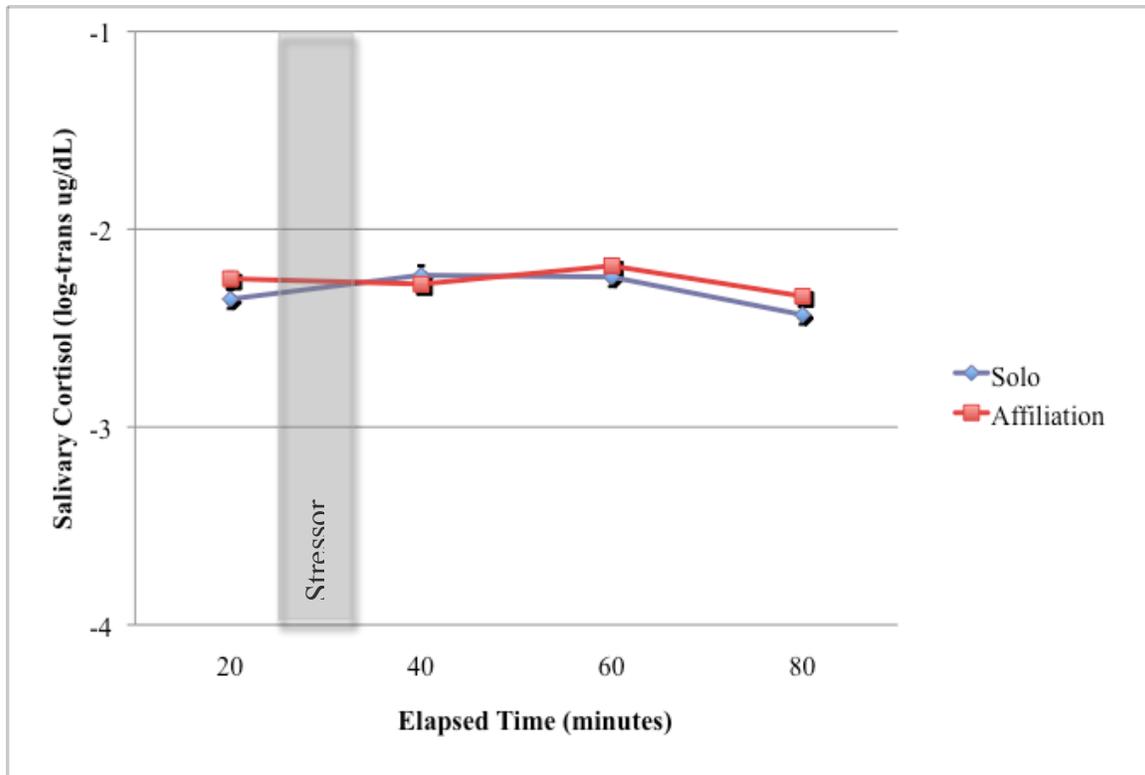
Taken together, these findings suggest that while there were no differences evident between conditions when comparing each time CORT time point, the availability of affiliation with a similar other did have a marginal influence on CORT levels across time. Specifically, the stress response pattern appeared to demonstrate a blunting effect whereby participants in the affiliation available condition had higher CORT levels at the beginning and end of the study compared to the solo condition. Thus, in this study, affiliation did not demonstrate a protective influence on stress physiology.

Table 6. *Study 1 Multilevel model of CORT response over time by condition.*

| <b>Parameter</b>          | <b>Estimate (SE)</b> | <b>df</b> | <b>F-statistic</b> | <b>P-value</b> |
|---------------------------|----------------------|-----------|--------------------|----------------|
| <i>Fixed</i>              |                      |           |                    |                |
| <b>Intercept</b>          | 2.02 (0.61)          | 1, 82     | 11.225             | .001**         |
| <b>CORT T1</b>            | 0.72 (0.09)          | 1, 82     | 67.199             | .000**         |
| <b>Time</b>               | -0.03 (0.03)         | 1, 167    | 10.352             | .002**         |
| <b>Time<sup>2</sup></b>   | -0.11 (0.04)         | 1, 167    | 9.252              | .003**         |
| <b>Condition</b>          | 0.04 (0.10)          | 1, 82     | 0.159              | .691           |
| <b>Time x Condition</b>   | -0.07 (0.04)         | 1, 167    | 2.912              | .090†          |
| <i>Random</i>             |                      |           | <i>Wald Z</i>      |                |
| <b>Intercept variance</b> | 0.18 (0.031)         |           | 5.601              | .000**         |

Note: †  $p < .10$ , \*  $p < .05$ , \*\*  $p < .01$ .

Figure 1. Study 1 CORT response over time by affiliation condition.



Note: Affiliation did not offer a protective effect, as the solo condition demonstrated somewhat lower post-stress CORT levels than their affiliation condition counterparts [ $F(1,167) = 2.912, p=.09$ ]. Error bars represent +/- 1 standard error of mean.

**Question 2: For whom is the availability of affiliation with a similar other beneficial? Are person by situation effects on stress physiology evident?**

To test possible person by situation effects on stress physiology, gender and personality traits (person factors) were included as predictors in multilevel models with random intercepts designed to assess the effect of affiliation availability (situation factor) on stress physiology across repeated measures.

First, when the role of gender was evaluated, the time x condition x gender interaction did not significantly predict CORT response [ $F(1,166) = 0.548, p = .46$ ], nor did the underlying 2-way interactions including gender or the main effect of gender ( $p$ -values ranged from .17-.76). Because there was no effect of gender alone, the final model reduced to the model presented in Table 6 (see Appendix D for further details about analyses).

Next, each of the Big Five personality traits was tested as a predictor of CORT response to stress over time by condition on their own, and none of the time x condition x personality trait interactions (nor their underlying interactions and main effects) were significant ( $p$ -values ranged from .16-.87; see Appendix D).

***Gender and Personality Jointly as Individual Difference Factors***

Given that gender alone and personality alone were not significant predictors of individual differences in stress response over time between the affiliation conditions, the two were examined simultaneously to determine if the combined role of both gender and personality traits were important. Five multilevel random intercepts models were

examined, each including one Big Five personality trait along with gender as predictors to the existing model (see Table 6) to predict CORT response. This meant that, in addition to the existing model predictors (time, time<sup>2</sup>, condition, and the covariate of baseline CORT), the 4-way interaction of time x condition x gender x personality trait (e.g., extraversion) and the underlying interactions and main effects were tested. Because only the main effect of quadratic time was significant across models testing each of the five personality traits (and not interactions of quadratic time with model factors), only the main effect of quadratic time was retained (see Table 6).

Of the five models testing each personality trait, one emerged to predict individual differences in CORT response over time between affiliation conditions. Specifically, the 4-way interaction including openness to experience significantly predicted CORT response [ $F(1,161) = 5.906, p = .02$ ; Table 7]. Women lower in openness to experience demonstrated a greater post-stress CORT response in the presence of another participant compared to being alone, whereas women high in openness did not show a CORT response regardless of condition (Figure 2). Men in all groups demonstrated a CORT response except those who were alone and high in openness. These findings indicate that, especially for those low in openness to experience, the availability of affiliation with another participant may have contributed to CORT stress response compared to being alone.

Additionally, the 4-way interaction including agreeableness marginally significantly predicted CORT response [ $F(1,161) = 3.753, p = .054$ ]. Women higher in agreeableness showed dampened post-stress time 3 CORT responses compared to their

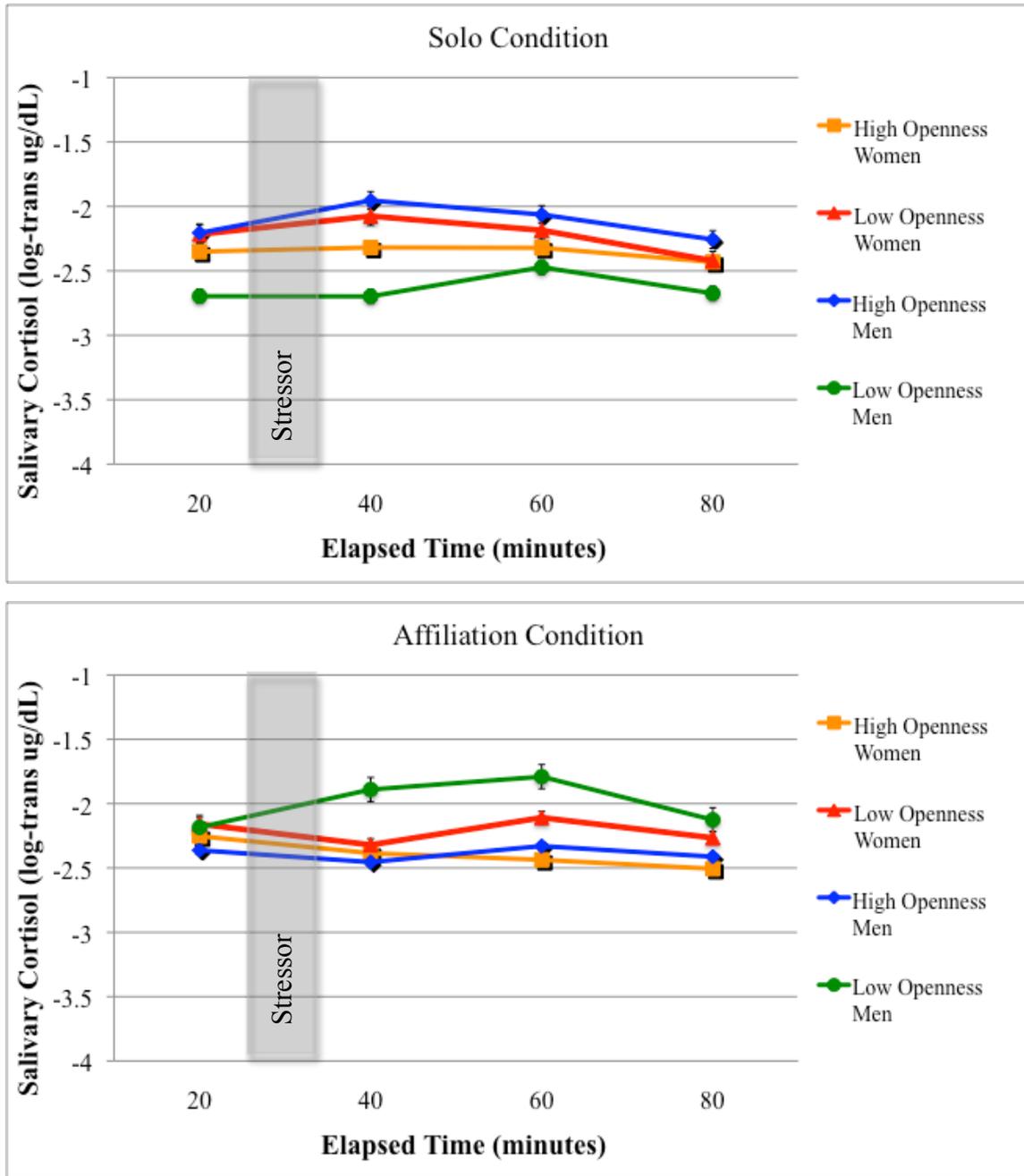
baseline CORT levels, particularly in the affiliation available condition (Figure 3). Men higher in agreeableness in the affiliation available condition appeared to show increased post-stress time 3 CORT response and poor recovery of post-stress time 4 CORT compared to the solo condition, as well as among those low in agreeableness.

Table 7. *Study 1 Multilevel model of CORT response over time by affiliation condition, gender, and openness to experience.*

| <b>Parameter</b>                            | <b>Estimate (SE)</b> | <b>df</b> | <b>F-statistic</b> | <b>P-value</b> |
|---------------------------------------------|----------------------|-----------|--------------------|----------------|
| <i>Fixed</i>                                |                      |           |                    |                |
| <b>Intercept</b>                            | 2.54 (0.97)          | 1, 76     | 13.025             | .001**         |
| <b>CORT T1</b>                              | 0.70 (0.09)          | 1, 76     | 56.298             | .000**         |
| <b>Condition</b>                            | 0.23 (1.15)          | 1, 76     | 0.669              | .461           |
| <b>Gender</b>                               | 0.48 (0.98)          | 1, 76     | 0.244              | .623           |
| <b>Time</b>                                 | 0.29 (0.26)          | 1, 161    | 0.180              | .672           |
| <b>Time<sup>2</sup></b>                     | -0.11 (0.03)         | 1, 161    | 9.486              | .002**         |
| <b>Openness</b>                             | -0.01 (0.02)         | 1, 76     | 0.880              | .351           |
| <b>Gender x Condition</b>                   | -1.68 (1.46)         | 1, 76     | 1.328              | .253           |
| <b>Time x Condition</b>                     | -0.51 (0.47)         | 1, 161    | 0.726              | .395           |
| <b>Openness x Condition</b>                 | -0.00 (0.03)         | 1, 76     | 0.729              | .396           |
| <b>Gender x Time</b>                        | -0.95 (0.40)         | 1, 161    | 0.399              | .528           |
| <b>Gender x Openness</b>                    | -0.01 (0.03)         | 1, 76     | 0.489              | .487           |
| <b>Time x Openness</b>                      | -0.01 (0.01)         | 1, 161    | 0.001              | .982           |
| <b>Gender x Time x Condition</b>            | 1.53 (0.60)          | 1, 161    | 6.461              | .012**         |
| <b>Gender x Condition x Openness</b>        | 0.04 (0.04)          | 1, 76     | 1.146              | .288           |
| <b>Condition x Time x Openness</b>          | 0.01 (0.01)          | 1, 161    | 1.169              | .281           |
| <b>Gender x Time x Openness</b>             | 0.03 (0.01)          | 1, 161    | 0.421              | .518           |
| <b>Condition x Time x Gender x Openness</b> | -0.04 (0.02)         | 1, 161    | 5.906              | .016*          |
| <i>Random</i>                               |                      |           | <i>Wald Z</i>      |                |
| <b>Intercept variance</b>                   | 0.18 (0.033)         |           | 5.447              | .000**         |

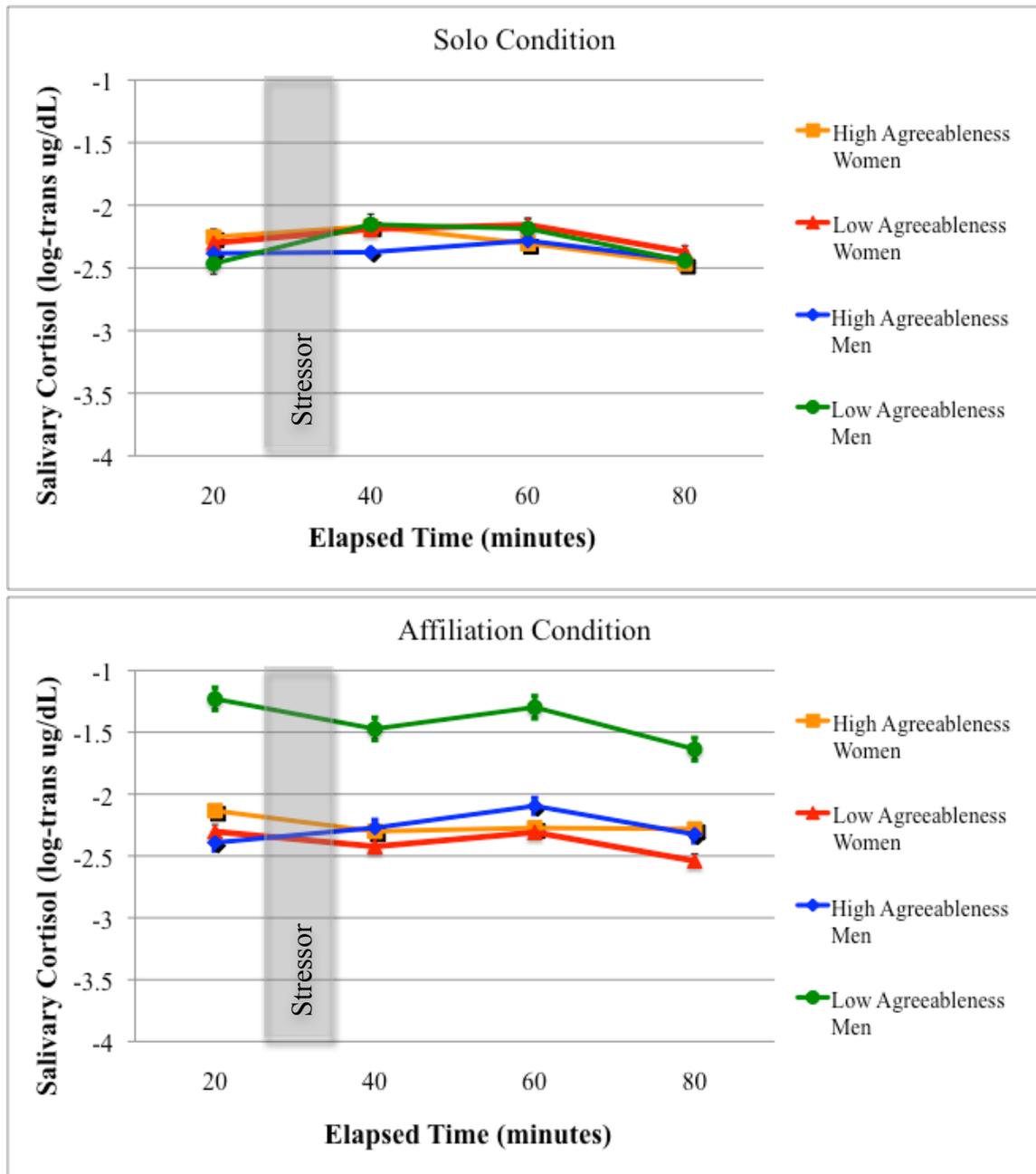
Note: †  $p < .10$ , \*  $p < .05$ , \*\*  $p < .01$ .

Figure 2. *Study 1 CORT response over time by affiliation condition, gender, and openness to experience.*



Note: Four-way interaction significantly predicts CORT [ $F(1,161) = 5.906, p = .02$ ].

Figure 3. *Study 1 CORT response over time by affiliation condition, gender, and agreeableness.*



Note: Four-way interaction marginally predicts CORT [ $F(1,161) = 3.753, p = .054$ ].

**Question 3: Under conditions when social affiliation with a similar other is available, to what extent do people engage in social support behaviors with others in the wake of a stressor? Does the extent of social support behaviors or language use vary depending on individual difference factors?**

Social support behavior and language use was examined within the subset of participants within the affiliation condition whose post-stress dyadic interactions were video recorded (n=24). In particular, seven components of social support behavior were measured, as well as seven markers of language use (see study 1 methods for detailed information regarding the variables of interest).

Firstly, there was a considerable absence of social support behavior with similar others in the wake of acute stress in this study. Of the 24 participants with video recorded dyadic interactions, 14 participants did not utter a single word during the post-stress recording time (M= 13 minutes and 39 seconds, sd= 2 minutes 23 seconds). Of the 10 remaining participants who did speak during the recording time, the amount of time speaking ranged from a mere 25 seconds to 4 minutes and 40 seconds (M= 2 minutes and 14 seconds, sd= 1 minutes 14 seconds).

In an attempt to identify who was more likely to speak during the post-stress dyadic interaction, mean personality trait scores were compared using a dichotomous variable of whether the participant spoke. Those participants who spoke had significantly higher extraversion [ $t(22) = -2.097, p=.05$ ] and openness to experience [ $t(22) = -2.183, p=.04$ ] personality scores. Gender did not predict who spoke during the interactions [ $\chi^2$

(1) = 0.96,  $p=.42$ ], nor the ratio of time speaking out of recording time [ $t(22) = -0.165$ ,  $p=.87$ ].

Given this absence of verbal interaction among the majority of the participants, inferential statistical comparisons of language use within the  $n=10$  participants by gender or personality were not possible. However, comparisons of word count and the coded social support behaviors were conducted, as verbalizations were not necessary in order to rate a behavior (e.g., conversations attempted was defined as an utterance or glance at the similar other, and conversations were coded as successful only if the other participant replied). Means and standard deviations are reported overall, as well as separately by gender (Table 8). Of the social support behaviors coded, only one appeared to differ by gender. Women made marginally significantly more stressor-relevant evaluative statements than men during the post-stress interaction [ $t(14.8) = 1.743$ ,  $p=.10$ ].

Personality traits were correlated with several social support behaviors during post-stress dyadic interactions with a similar other (Table 9). In particular, participants higher in openness to experience had significantly higher ratings of the extent, quality, and intimacy of their role in the dyadic interaction, as well as the number of stressor-relevant factual statements they made, and overall word count. Furthermore, openness to experience was moderately positively correlated with each social support behavior, however, only those listed above reached at least marginal significance. Additionally, agreeableness was marginally positively correlated with quality of interaction, and conscientiousness was marginally negatively correlated with intimacy of interaction.

Although extraversion was moderately positively correlated with each social support behavior, none of these correlations reached marginal or greater levels of significance.

Notably, however, use of the sign test indicates that the number of correlations in a consistent direction between the social support behaviors and the traits of extraversion (10 out of 10 positive correlations,  $p=.002$ ), conscientiousness (10 out of 10 negative correlations,  $p=.002$ ), and openness to experience (10 out of 10 positive correlations,  $p=.002$ ) each significantly exceeds what chance would predict. This suggests that the correlations between social support behavior and the personality traits of extraversion and conscientiousness may have joined openness in reaching statistical significance given greater power from a larger sample size, and as such may provide further support for the existence of relationships between personality and social support behavior in the wake of stress.

Table 8. *Study 1 Affiliation Condition Post-stress Interaction Behaviors by Gender.*

|                                     | <b>Combined<br/>Mean (SD)</b> | <b>Women (n=14)<br/>Mean (SD)</b> | <b>Men (n=10)<br/>Mean (SD)</b> | <b>t-value<br/>(df=22)</b> |
|-------------------------------------|-------------------------------|-----------------------------------|---------------------------------|----------------------------|
| <b>Behavior</b>                     |                               |                                   |                                 |                            |
| <b>Ratio of Time<br/>Speaking</b>   | 0.08 (0.11)                   | 0.07 (0.10)                       | 0.08 (0.14)                     | -0.165                     |
| <b>Conversations<br/>Attempted</b>  | 2.29 (3.57)                   | 2.79 (4.06)                       | 1.60 (2.80)                     | 0.796                      |
| <b>Conversations<br/>Successful</b> | 1.42 (2.84)                   | 1.79 (3.26)                       | 0.90 (2.18)                     | 0.745                      |
| <b>Extent</b>                       | 2.67 (2.26)                   | 2.57 (1.79)                       | 2.80 (2.90)                     | -0.221                     |
| <b>Quality</b>                      | 4.38 (1.17)                   | 4.29 (1.20)                       | 4.50 (1.18)                     | -0.434                     |
| <b>Intimacy</b>                     | 1.67 (1.31)                   | 1.64 (1.15)                       | 1.70 (1.57)                     | -0.103                     |
| <b>Stress-Relevant</b>              | 0.88 (1.68)                   | 1.00 (1.80)                       | 0.70 (1.57)                     | 0.424                      |
| <b>Evaluative</b>                   | 0.50 (1.14)                   | 0.79 (1.42)                       | 0.10 (0.32)                     | 1.743 <sup>†</sup>         |
| <b>Factual</b>                      | 0.38 (0.88)                   | 0.21 (0.43)                       | 0.60 (1.27)                     | -0.927                     |
| <b>Language Use</b>                 |                               |                                   |                                 |                            |
| <b>Word Count</b>                   | 194.1 (283.6)                 | 176.5 (233.0)                     | 218.7 (355.0)                   | -0.329                     |
| <b>I</b>                            | 7.07 (2.33)                   | 7.45 (2.71)                       | 6.16 (0.79)                     | N/A                        |
| <b>We</b>                           | 0.59 (0.43)                   | 0.65 (0.49)                       | 0.44 (0.27)                     | N/A                        |
| <b>You</b>                          | 3.15 (1.42)                   | 3.05 (1.63)                       | 3.38 (0.98)                     | N/A                        |
| <b>Positive Emotion</b>             | 3.82 (2.02)                   | 4.14 (2.25)                       | 3.09 (1.44)                     | N/A                        |
| <b>Negative Emotion</b>             | 1.72 (1.04)                   | 1.73 (0.83)                       | 1.70 (1.68)                     | N/A                        |
| <b>Assents</b>                      | 4.45 (2.23)                   | 4.53 (2.24)                       | 4.25 (2.69)                     | N/A                        |

*Note: <sup>†</sup> p < .10, \* p < .05, \*\* p < .01. Means, standard deviations, and t-tests presented above reflect n=24 participants. With the exception of word count, the remaining language use variables had n=10 participants (7 women, 3 men), and thus were too small for comparison.*

Table 9. *Study 1 Correlations of Affiliation Condition Post-stress Interaction Behaviors by Personality.*

|                                                                                | <b>Ext</b> | <b>Agr</b> | <b>Con</b> | <b>Neur</b> | <b>Open</b> |
|--------------------------------------------------------------------------------|------------|------------|------------|-------------|-------------|
| <b>Behavior</b>                                                                |            |            |            |             |             |
| <b>Ratio of Time Speaking Conversations Attempted Conversations Successful</b> | 0.25       | 0.10       | -0.33      | -0.04       | 0.33        |
| <b>Extent</b>                                                                  | 0.30       | 0.09       | -0.33      | -0.08       | 0.42*       |
| <b>Quality</b>                                                                 | 0.18       | 0.38†      | -0.11      | -0.17       | 0.53**      |
| <b>Intimacy</b>                                                                | 0.27       | 0.00       | -0.36†     | -0.01       | 0.35†       |
| <b>Stress-Relevant</b>                                                         | 0.25       | 0.21       | -0.30      | -0.16       | 0.30        |
| <b>Evaluative</b>                                                              | 0.21       | 0.30       | -0.15      | -0.03       | 0.18        |
| <b>Factual</b>                                                                 | 0.20       | 0.00       | -0.36†     | -0.27       | 0.34†       |
| <b>Language Use</b>                                                            |            |            |            |             |             |
| <b>Word Count</b>                                                              | 0.26       | 0.06       | -0.35†     | -0.07       | 0.35†       |
| <b>I</b>                                                                       | <i>N/A</i> | <i>N/A</i> | <i>N/A</i> | <i>N/A</i>  | <i>N/A</i>  |
| <b>We</b>                                                                      | <i>N/A</i> | <i>N/A</i> | <i>N/A</i> | <i>N/A</i>  | <i>N/A</i>  |
| <b>You</b>                                                                     | <i>N/A</i> | <i>N/A</i> | <i>N/A</i> | <i>N/A</i>  | <i>N/A</i>  |
| <b>Positive Emotion</b>                                                        | <i>N/A</i> | <i>N/A</i> | <i>N/A</i> | <i>N/A</i>  | <i>N/A</i>  |
| <b>Negative Emotion</b>                                                        | <i>N/A</i> | <i>N/A</i> | <i>N/A</i> | <i>N/A</i>  | <i>N/A</i>  |
| <b>Assents</b>                                                                 | <i>N/A</i> | <i>N/A</i> | <i>N/A</i> | <i>N/A</i>  | <i>N/A</i>  |

*Note: † p < .10, \* p < .05, \*\* p < .01. Correlations presented above reflect n=24 participants. With the exception of word count, the remaining language use variables had n=10 participants, and thus were too small for comparison.*

**Question 4: Under conditions when social affiliation with a similar other is available, which features of social support behavior are related to physiological recovery from acute stress?**

First and foremost, in an effort to understand how the presence or absence of social affiliation with a similar other affected stress physiology, the role of the dichotomous variable indicating whether the participant spoke at all during the recording time was assessed. There were no mean group differences at any of the four CORT time points based on the dichotomous variable of whether the participant spoke ( $p$ -values ranged from .20-.89). However, ratio of time speaking (ratio computed from the amount of time speaking out of the possible recording time) was significantly negatively correlated with post-stress CORT at time 3, which reflects CORT levels immediately preceding the interaction period ( $r = -0.44, p = .03$ ). This indicates that individuals with higher CORT stress levels immediately following the stressor were less likely to interact with a similar other than those with lower CORT responses to the stressor.

Next, the role of features of social support behavior and language were investigated to determine their potential influence on recovery CORT levels. Partial correlations between recovery CORT levels controlling for baseline CORT levels and each social support behavior and language use measure were performed (Table 10). Each behavioral measure was moderately negatively correlated with recovery CORT levels controlling for baseline CORT levels, with the exception of quality of interaction. Of the social support behaviors with moderate negative correlations with recovery of time 4 CORT levels, two behaviors in particular, the number of conversations attempted and the

number of conversations successful, reached significance. Taken together, these findings indicated that attempting to start and successfully starting conversations with a similar other in the wake of a stressor, and greater social support behaviors in general, were related to better physiological recovery from the stressor.

As noted previously, due to the sparse level of verbal interactions between the similar other dyads, language use measures could not be analyzed. However, the relationship between word count and recovery from stress was consistent with the behavioral measures. Word count demonstrated a moderate negative correlation with time 4 CORT controlling for baseline CORT that approached, but did not reach, marginal significance ( $r = -0.32, p = .13$ ).

Based on these findings, which demonstrate a significant correlation between greater social support behavior of word count and beneficial post-stress CORT recovery at time 4, simple mediation analyses were conducted to examine if openness mediated this relationship using the 4-step testing process (see Baron & Kenny, 1986). As discussed with regard to research question 3, openness to experience in particular appeared to be significantly positively correlated with most social support behaviors measured, including word count. The social support factor of word count was a significant predictor of time 4 CORT, controlling for time 1 ( $t = -2.258, p = .036$ ; step 1), and openness to experience was a marginally significant predictor of word count ( $t = 1.751, p = .095$ ; step 2). However, when partial mediation was assessed by examining the effect of openness in predicting CORT at time 4 controlling for the effect of word count, openness was no longer a significant predictor ( $t = .303, p = .77$ ; step 3). Taken

together, these analyses suggest that although personality and social support behavior are related, and social support is related to CORT recovery at time 4, the personality trait openness does not appear to serve as a mediator of the relationship between social support and stress recovery.

## **SUMMARY**

Overall, the results of study 1 indicated that the mere availability of affiliation with a similar other did not have a protective effect on stress physiology. Further, personality (particularly, openness to experience) and gender together, along with availability of affiliation, are important predictors of stress physiology over time. Personality is also an important factor in determining to what extent individuals will engage in social support behaviors. Again, openness to experience emerged as an important factor, and indicated that people who were higher in openness to experience were more likely to engage in social support behaviors overall. Finally, the greater number of conversations attempted and successfully started were each significantly related to better CORT recovery from acute stress.

Table 10. *Study 1 Partial correlations of Affiliation Condition Post-stress Interaction Behaviors by Time 4 CORT level controlling for Baseline CORT level.*

| <b>Behavior</b>                 | <b>CORT<br/>T4</b> | <b>Language Use</b>     | <b>CORT<br/>T4</b> |
|---------------------------------|--------------------|-------------------------|--------------------|
| <b>Ratio of Time Speaking</b>   | -0.34              | <b>Word Count</b>       | -0.32              |
| <b>Conversations Attempted</b>  | -0.48*             | <b>I</b>                | N/A                |
| <b>Conversations Successful</b> | -0.42*             | <b>We</b>               | N/A                |
| <b>Extent</b>                   | -0.28              | <b>You</b>              | N/A                |
| <b>Quality</b>                  | -0.05              | <b>Positive Emotion</b> | N/A                |
| <b>Intimacy</b>                 | -0.33              | <b>Negative Emotion</b> | N/A                |
| <b>Stress-Relevant</b>          | -0.35†             | <b>Assents</b>          | N/A                |
| <b>Evaluative</b>               | -0.31              |                         |                    |
| <b>Factual</b>                  | -0.28              |                         |                    |

*Note: †  $p < .10$ , \*  $p < .05$ , \*\*  $p < .01$ . Correlations presented above reflect  $n=24$  participants. With the exception of word count, the remaining language use variables had  $n=10$  participants, and thus were too small for comparison.*

## Study 2

### DESCRIPTIVE ANALYSES

First, descriptive information comparing measures of personality, anxiety, and CORT by condition (solo versus trusted friend affiliation available) for all 79 included participants (n=43 solo, n=36 affiliation) was examined (Table 11). Mean scores and variances did not significantly differ on any of these measures of personality, anxiety, or CORT by condition (regardless of the inclusion/exclusion of the five participants with extreme hormone data) with one exception. Post-stress time 3 CORT response was significantly lower for the trusted friend affiliation group compared to their counterparts who roomed alone.

Next, descriptive information comparing measures of personality, anxiety, and CORT by participant gender (n=46 women, n=33 men) was assessed (Table 12). Mean scores and variances did not significantly differ on any of these measures by gender, with the exception of BFI Neuroticism, time 2 pre-stress CORT level, and time 3 post-stress CORT level. Women demonstrated significantly higher mean neuroticism scores compared to men, while men demonstrated significantly higher time 2 and time 3 CORT levels compared to women. Despite these gender differences in CORT levels, baseline CORT levels were not significantly different.

Table 11. *Study 2 self-report and hormone measures by condition (solo vs. trusted friend affiliation).*

|                              | <b>Solo (n=43)<br/>Mean (SD)</b> | <b>Affiliation (n=36)<br/>Mean (SD)</b> | <b>t-value (n)</b> |
|------------------------------|----------------------------------|-----------------------------------------|--------------------|
| <b>CORT</b>                  |                                  |                                         |                    |
| <b>T1 Pre-stress 20 min</b>  | -2.07 (0.63)                     | -2.12 (0.51)                            | t (77) = 0.394     |
| <b>T2 Pre-stress 40 min</b>  | -2.00 (0.68)                     | -2.15 (0.58)                            | t (77) = 1.104     |
| <b>T3 Post-stress 60 min</b> | -1.91 (0.54)                     | -2.18 (0.60)                            | t (76) = 2.083*    |
| <b>T4 Post-stress 80 min</b> | -2.02 (0.55)                     | -2.15 (0.56)                            | t (77) = 1.057     |
| <b>BFI</b>                   |                                  |                                         |                    |
| <b>Extroversion</b>          | 29.0 (6.01)                      | 27.8 (6.16)                             | t (76) = 0.849     |
| <b>Agreeableness</b>         | 36.1 (6.31)                      | 36.2 (5.30)                             | t (77) = -0.091    |
| <b>Conscientiousness</b>     | 32.1 (6.61)                      | 33.0 (5.48)                             | t (77) = -0.659    |
| <b>Neuroticism</b>           | 20.2 (6.68)                      | 21.8 (6.26)                             | t (77) = -1.108    |
| <b>Openness</b>              | 36.2 (5.82)                      | 36.8 (5.64)                             | t (77) = -0.439    |
| <b>STAI</b>                  |                                  |                                         |                    |
| <b>Trait-level Anxiety</b>   | 25.4 (4.15)                      | 26.8 (4.72)                             | t (72) = -1.398    |
| <b>State-level Anxiety</b>   | 22.8 (5.11)                      | 22.8 (5.48)                             | t (69) = -0.002    |

Note: †  $p < .10$ , \*  $p < .05$ , \*\*  $p < .01$ .

Table 12. Study 2 self-report and hormone measures by gender.

|                              | <b>Women (n=46)</b><br>mean (SD) | <b>Men (n=33)</b><br>mean (SD) | <b>t-value (n)</b> |
|------------------------------|----------------------------------|--------------------------------|--------------------|
| <b>CORT</b>                  |                                  |                                |                    |
| <b>T1 Pre-stress 20 min</b>  | -2.11 (0.61)                     | -2.07 (0.53)                   | t (77) = -0.283    |
| <b>T2 Pre-stress 40 min</b>  | -2.18 (0.66)                     | -1.92 (0.58)                   | t (77) = -1.795†   |
| <b>T3 Post-stress 60 min</b> | -2.14 (0.59)                     | -1.87 (0.53)                   | t (76) = -2.107*   |
| <b>T4 Post-stress 80 min</b> | -2.16 (0.62)                     | -1.97 (0.44)                   | t (77) = -1.524    |
| <b>BFI</b>                   |                                  |                                |                    |
| <b>Extroversion</b>          | 28.3 (5.94)                      | 28.6 (6.42)                    | t (76) = -0.242    |
| <b>Agreeableness</b>         | 36.9 (6.03)                      | 35.0 (5.44)                    | t (77) = 1.431     |
| <b>Conscientiousness</b>     | 32.6 (6.42)                      | 32.3 (5.72)                    | t (77) = 0.243     |
| <b>Neuroticism</b>           | 23.0 (6.04)                      | 18.1 (6.10)                    | t (77) = 3.548**   |
| <b>Openness</b>              | 36.2 (5.61)                      | 36.9 (5.89)                    | t (77) = -0.579    |
| <b>STAI</b>                  |                                  |                                |                    |
| <b>Trait-level Anxiety</b>   | 25.9 (4.84)                      | 26.3 (3.93)                    | t (72) = -0.354    |
| <b>State-level Anxiety</b>   | 22.1 (4.74)                      | 23.8 (5.78)                    | t (69) = -1.361    |

Note: †  $p < .10$ , \*  $p < .05$ , \*\*  $p < .01$ .

Next, the relationships between the Big Five personality traits and CORT were assessed. Correlations between each personality trait and each CORT sample are reported in Table 13 both for the entire sample and within participant gender (n=46 women, n=33 men). Overall, aspects of personality were significantly correlated with baseline CORT and time 2 CORT levels. In particular, CORT at baseline was marginally positively correlated with extroversion and marginally negatively correlated with neuroticism. Neuroticism was also marginally negatively correlated with CORT levels at time 2.

Among women, extraversion was marginally positively correlated with CORT during baseline and time 2, while conscientiousness was marginally positively correlated with CORT levels pre-stress during time 2 and post-stressor at time 3. Also, openness to experience was marginally positively correlated with time 2 CORT levels. No significant correlations emerged between personality and time 4 CORT levels. Within men, neuroticism was significantly negatively correlated with CORT levels post-stress during time 4, and showed a marginally significant negative correlation with baseline CORT levels.

As expected, CORT levels among each time point were highly positively correlated both across the sample overall and within gender. Personality traits were relatively uncorrelated to one another with the exception of neuroticism, which was significantly negatively correlated with extraversion, agreeableness, and conscientiousness. Also, conscientiousness was positively correlated with agreeableness,

and openness to experience was positively correlated with extraversion and agreeableness.

No significant correlations were present between CORT levels pre-stress during time 2, or post-stress at time 3 and time 4 and self-reported state anxiety or trait anxiety. Marginal significant positive correlations were observed for baseline CORT levels and trait anxiety (overall  $r=.20, p=.09$ ), and this was particularly the case for women ( $r=.34, p=.03$ ), and not for men ( $r=-.07, p=.72$ ).

Table 13. Study 2 CORT hormone by personality correlations by gender.

|                   | <b>T1</b> | <b>T2</b> | <b>T3</b> | <b>T4</b> | <b>Ext</b> | <b>Agr</b> | <b>Cons</b> | <b>Neur</b> |
|-------------------|-----------|-----------|-----------|-----------|------------|------------|-------------|-------------|
| <i>Overall</i>    |           |           |           |           |            |            |             |             |
| <i>(n=79)</i>     |           |           |           |           |            |            |             |             |
| <b>CORT T2</b>    | .74**     |           |           |           |            |            |             |             |
| <b>CORT T3</b>    | .53**     | .80**     |           |           |            |            |             |             |
| <b>CORT T4</b>    | .60**     | .77**     | .87**     |           |            |            |             |             |
| <b>BFI Ext</b>    | .19†      | .15       | .08       | .04       |            |            |             |             |
| <b>BFI Agr</b>    | .03       | -.04      | -.02      | -.07      | .13        |            |             |             |
| <b>BFI Con</b>    | .07       | .10       | .18       | .06       | .16        | .21†       |             |             |
| <b>BFI Neur</b>   | -.18†     | -.19†     | -.16      | -.08      | -.28**     | -.19†      | -.30**      |             |
| <b>BFI Open</b>   | .08       | .16       | .07       | .10       | .44**      | .20†       | -.09        | -.01        |
| <i>Women Only</i> |           |           |           |           |            |            |             |             |
| <i>(n=46)</i>     |           |           |           |           |            |            |             |             |
| <b>CORT T2</b>    | .79**     |           |           |           |            |            |             |             |
| <b>CORT T3</b>    | .65**     | .83**     |           |           |            |            |             |             |
| <b>CORT T4</b>    | .65**     | .77**     | .89**     |           |            |            |             |             |
| <b>BFI Ext</b>    | .26†      | .27†      | .17       | .07       |            |            |             |             |
| <b>BFI Agr</b>    | .03       | .01       | .06       | .03       | .12        |            |             |             |
| <b>BFI Con</b>    | .24       | .25†      | .25†      | .11       | .11        | .16        |             |             |
| <b>BFI Neur</b>   | -.11      | -.05      | .06       | .15       | -.15       | -.36**     | -.21        |             |
| <b>BFI Open</b>   | .14       | .25†      | .22       | .24       | .45**      | .19        | -.02        | .06         |
| <i>Men Only</i>   |           |           |           |           |            |            |             |             |
| <i>(n=33)</i>     |           |           |           |           |            |            |             |             |
| <b>CORT T2</b>    | .68**     |           |           |           |            |            |             |             |
| <b>CORT T3</b>    | .33†      | .73**     |           |           |            |            |             |             |
| <b>CORT T4</b>    | .53**     | .77**     | .84**     |           |            |            |             |             |
| <b>BFI Ext</b>    | .10       | -.05      | -.04      | -.01      |            |            |             |             |
| <b>BFI Agr</b>    | .05       | -.04      | -.07      | -.22      | .15        |            |             |             |
| <b>BFI Con</b>    | -.24      | -.17      | .09       | -.02      | .24        | .30†       |             |             |
| <b>BFI Neur</b>   | -.31†     | -.24      | -.28      | -.34*     | -.47**     | -.16       | -.53**      |             |
| <b>BFI Open</b>   | -.02      | -.01      | -.19      | -.19      | .43**      | .27        | -.18        | -.04        |

Note: †  $p < .10$ , \*  $p < .05$ , \*\*  $p < .01$ .

## RESEARCH QUESTION RESULTS

### **Question 1B: Does the availability social affiliation with a trusted friend have a protective effect on stress physiology compared to being alone?**

As in study 1, a multilevel model with random intercepts employed to assess the effect of the availability of affiliation on stress physiology over time using repeated measures of participants. Specifically, CORT levels across time 2 (pre-stress, 40 minutes elapsed), 3 (post-stress, 60 minutes elapsed), and 4 (post-stress 80 minutes elapsed) were the CORT response outcome variable, and CORT at time 1 (pre-stress baseline) was included as a covariate to control for baseline CORT level. To test whether there was an effect of availability of affiliation on overall stress physiology over time, study condition (solo vs. affiliation available) was included as a predictor along with time (both linear and quadratic; to reflect change over time 2, 3, and 4), and the interactions of condition x time (linear and quadratic). The interaction of condition x time<sup>2</sup> controlling for baseline CORT was a marginally significant predictor of CORT response [ $F(1,153) = 3.417$ ,  $p = .07$ ] along with the underlying main effect of condition (Table 14). This finding suggests that trajectories of CORT levels across time differed based on whether affiliation with a trusted friend was available, with the solo condition appearing to demonstrate a CORT response over time characterized by a quadratic function, while their affiliation condition counterparts appeared to have reduced, flat CORT responses over time (Figure 4).

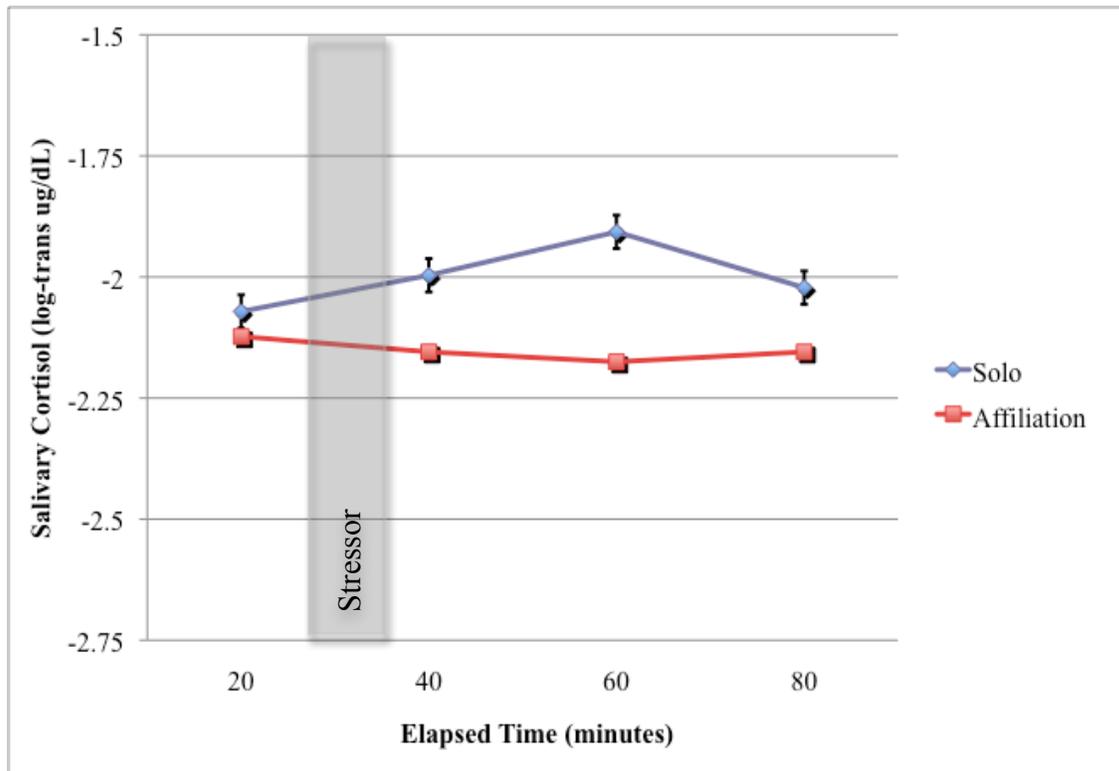
Further, as noted in the descriptive results, mean post-stress CORT levels at time 3 did differ significantly by condition, with the affiliation available group showing significantly lower time 3 CORT response values compared to the solo condition (see Table 11). Taken together, this suggests that there was a significant difference evident between conditions in CORT response to the stressor. Overall, availability of affiliation did appear offer a protective effect on stress physiology across all time points generally, and those participants who had a friend available to affiliate with demonstrated lower time 3 CORT response to stress compared to those who roomed alone.

Table 14. *Study 2 Multilevel model of CORT response over time by condition.*

| <b>Parameter</b>                    | <b>Estimate (SE)</b> | <b>df</b> | <b>F-statistic</b> | <b>P-value</b> |
|-------------------------------------|----------------------|-----------|--------------------|----------------|
| <i>Fixed</i>                        |                      |           |                    |                |
| <b>Intercept</b>                    | -0.83 (0.19)         | 1, 79     | 16.97              | .000**         |
| <b>CORT T1</b>                      | 0.63 (0.08)          | 1, 76     | 63.132             | .000**         |
| <b>Condition</b>                    | 0.24 (0.10)          | 1, 118    | 5.532              | .020*          |
| <b>Time</b>                         | -0.00 (0.03)         | 1, 153    | 0.098              | .755           |
| <b>Time<sup>2</sup></b>             | 0.02 (0.05)          | 1, 153    | 1.614              | .206           |
| <b>Time x Condition</b>             | -0.01 (0.04)         | 1, 153    | 0.097              | .756           |
| <b>Time<sup>2</sup> x Condition</b> | -0.13 (0.07)         | 1, 153    | 3.417              | .066†          |
| <i>Random</i>                       |                      |           | <i>Wald Z</i>      |                |
| <b>Intercept variance</b>           | 0.14 (0.027)         |           | 5.328              | .000**         |

Note: †  $p < .10$ , \*  $p < .05$ , \*\*  $p < .01$ .

Figure 4. Study 2 CORT response over time by affiliation condition.



Note: The interaction of condition  $\times$  time<sup>2</sup> controlling for baseline CORT was a marginally significant predictor of CORT response [ $F(1,153) = 3.417, p = .07$ ]. Error bars represent +/- 1 standard error of mean.

**Question 2: For whom is the availability of affiliation with a trusted friend beneficial? Are person by situation effects on stress physiology evident?**

As in study 1, to test possible person by situation effects on stress physiology, gender and personality traits (person factors) were included as predictors in multilevel models with random intercepts designed to assess the effect of affiliation availability (situation factor) on stress physiology across repeated measures (see Table 14).

First, the effect of gender on CORT response did not depend on time or condition ( $p$ -values ranged from .33-.90; see Appendix D). However, there was a main effect of gender in predicting CORT response regardless of time or condition [ $F(1,75) = 5.096, p=.03$ ], with men demonstrating higher CORT overall compared to women (Figure 5). Consequently, the main effect of gender on CORT was retained in subsequent models testing personality traits.

Next, each of the Big Five personality traits was assessed as a potential explanation of individual differences in stress response over time (see Appendix D for further details). Of the five models, the individual difference factors of extraversion [ $F(1,149) = 2.741, p=.10$ ], conscientiousness [ $F(1,151) = 5.828, p=.02$ ], and openness to experience [ $F(1,151) = 3.878, p=.05$ ] appear to be important predictors of situational effects of affiliation availability on CORT response to stress over time.

Participants higher in extraversion in the presence of their friend appeared to demonstrate a buffering effect on CORT response over time, with low peak response CORT levels. Further, participants low in extraversion in the affiliation condition

showed elevated post-stress time 3 CORT levels and poorer CORT recovery at time 4 compared to baseline CORT than their higher extraversion counterparts (Figure 6).

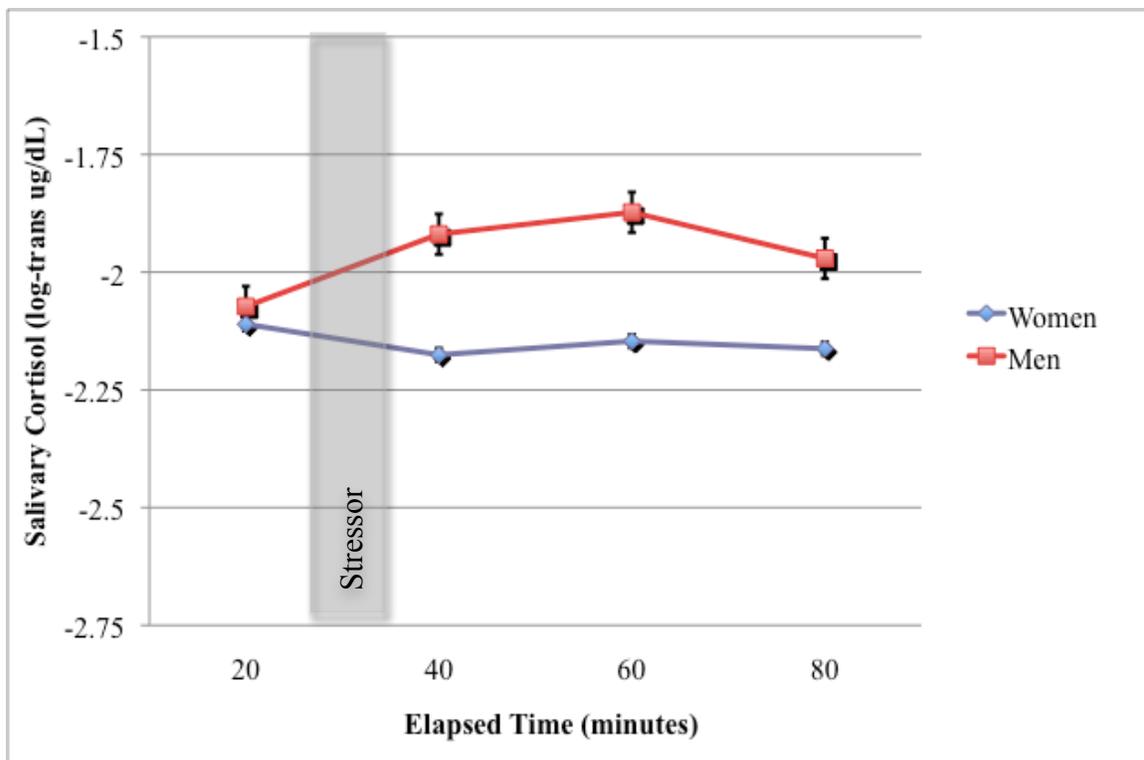
Participants lower in conscientiousness in the friend-affiliation condition appeared to have blunting effect with poor recovery at time 4, whereby CORT actually increased at that time point. In contrast, participants higher in conscientiousness in the affiliation condition appeared to demonstrate a beneficial pattern of decreasing CORT over time and better recovery at time 4. Within the solo condition, CORT across time did not appear to significantly differ based on conscientiousness (Figure 7).

Participants low in openness to experience did not appear to have a stress response in the presence of their friend, thus showing a buffering effect on CORT response over time. However, participants higher in openness to experience showed a blunting effect over time whereby their CORT levels were elevated in general, but did not show a peak and recover pattern. Participants low in openness to experience in the solo condition demonstrated a CORT response at time 3, and showed poor recovery at time 4, whereas solo participants high in openness showed a CORT response but demonstrated better recovery (Figure 8).

Given that personality was a significant predictor of individual differences in stress response over time between conditions along with the main effect of gender, the gender and personality were examined simultaneously to determine if their combined role was important. However, none of the time (linear or quadratic) x condition x gender x personality trait interactions emerged to significantly predict individual differences in CORT response over time between solo vs. friend-affiliation conditions ( $p$ -values ranged

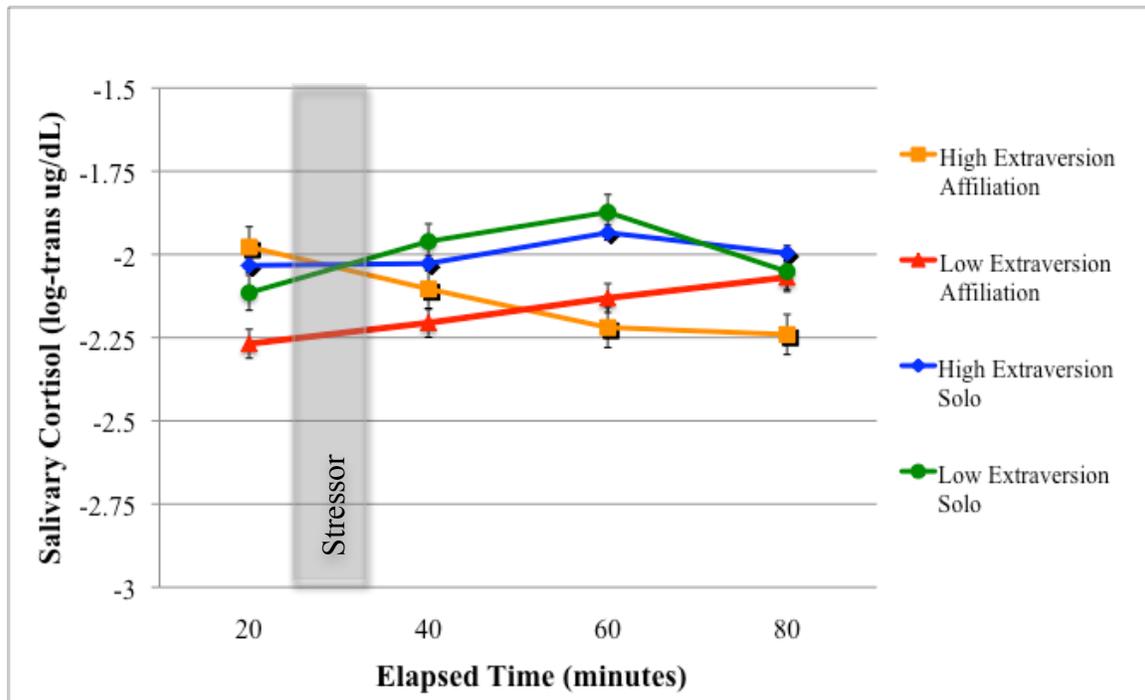
from .14-.67; see Appendix D). This indicates that although gender is an important factor, the personality x condition x time interactions did not vary significantly based on gender. Overall, these findings highlight the contributions of both gender and personality and provide support the existence of person by situation effects in stress physiology.

Figure 5. Study 2 CORT response over time by gender.



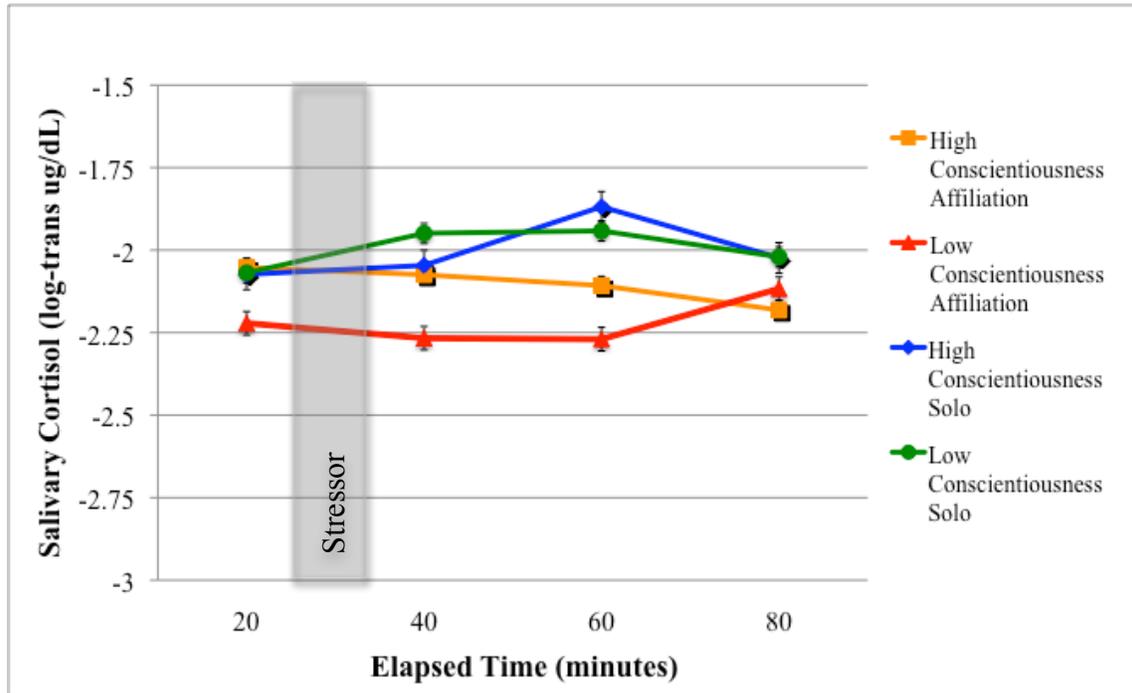
Note: Main effect of gender predicts overall CORT regardless of time, controlling for baseline [ $F(1,75) = 5.096, p = .03$ ]. Error bars represent  $\pm 1$  standard error of mean.

Figure 6. Study 2 CORT response over time by affiliation condition and extraversion.



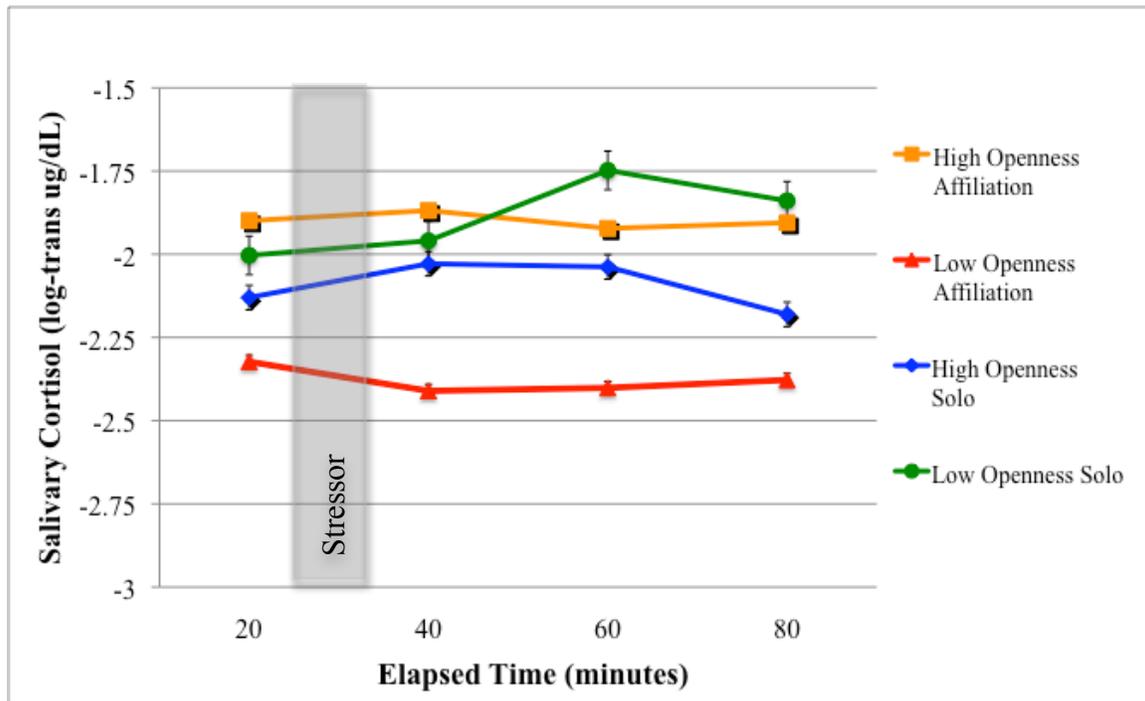
Note: Interaction of time  $\times$  condition  $\times$  extraversion marginally predicts CORT [ $F(1,149) = 2.741, p = .10$ ]. Error bars represent  $\pm 1$  standard error of mean.

Figure 7. Study 2 CORT response over time by affiliation condition and conscientiousness.



Note: Interaction of time  $\times$  condition  $\times$  conscientiousness significantly predicts CORT [ $F(1,151) = 5.828, p=.02$ ]. Error bars represent  $\pm 1$  standard error of mean.

Figure 8. Study 2 CORT response over time by affiliation condition and openness to experience.



Note: Interaction of time  $\times$  condition  $\times$  openness to experience significantly predicts CORT [ $F(1,151) = 3.878, p = .05$ ]. Error bars represent  $\pm 1$  standard error of mean.

**Question 3: Under conditions when social affiliation with a trusted friend is available, to what extent do people engage in social behavior with others in the wake of a stressor? Does the extent of social behaviors or language use vary depending on individual difference factors?**

Social behavior and language use during video recorded post-stress dyadic interactions were examined within the close friend affiliation available condition (n = 36 participant-friend dyads). As in study 1, seven components of social support behavior were measured, as well as seven markers of language use (see study 1 methods for detailed information regarding the variables of interest). Additionally, LSM (the extent to which language use among members of each dyad were in sync) was measured among each dyad in this study (see study 2 methods for detailed information on LSM).

Firstly, there was immense variance in the extent to which people engaged in social support behavior with their trusted friend in the wake of acute stress in this study, ranging from mere seconds to constant interaction during the post-stress period. In contrast with study 1, all 36 participants spoke during the post-stress dyadic interaction recording time (M= 17 minutes and 36 seconds, sd= 3 minutes 56 seconds). The amount of time participants spoke ranged from a meager 20 seconds to 9 minutes and 2 seconds (M= 3 minutes and 56 seconds, sd= 2 minutes 22 seconds). The amount of time participants' friends spoke ranged from 13 seconds to 9 minutes and 25 seconds (M= 3 minutes and 43 seconds, sd= 2 minutes 27 seconds). Additionally, the amount of time a

participant spoke was highly positively correlated with the amount of time their friend spoke ( $r= 0.76, p < .00$ ).

In an attempt to identify who was more likely to engage in social support behaviors and language use during the post-stress dyadic interaction, individual difference factors of gender and personality were examined. Social support behavior and language use means and standard deviations are reported overall, as well as separately by gender (Table 15). Of the social support behaviors coded, one support behavior appeared to differ by gender. The quality of the post-stress interaction for women participants was rated as slightly positive on average, which was significantly higher quality compared to men, whose mean quality of interaction was rated as neutral on average (see study 1 methods for ratings description). Of the markers of social support language use examined, only assents (yes, agree, etc) differed by gender, with women using significantly more assent words than men.

Personality traits were correlated with several social support behaviors and markers of language use during post-stress dyadic interactions with a trusted friend (Table 16). Specifically, participants higher in extraversion as well as those higher in agreeableness had significantly higher ratings of the quality of their role in dyadic interactions. Additionally, conscientiousness was significantly positively correlated with the ratings of both the extent and intimacy of their role in the dyadic interactions. Participants higher in neuroticism appeared to have significantly fewer stressor-relevant conversations overall, and fewer evaluative stressor-relevant conversations than those

lower in neuroticism, while participant higher in openness to experience appeared to engage in greater factual stressor-relevant conversations.

As in study 1, use of the sign test indicates that the number of correlations in a consistent direction between the social support behaviors (including word count) and the traits of agreeableness (9 out of 10 positive correlations,  $p=.02$ ), neuroticism (10 out of 10 negative correlations,  $p=.002$ ), and openness to experience (9 out of 10 positive correlations,  $p=.02$ ) each significantly exceeds what chance would predict. This suggests that additional correlations between social support behavior and the personality traits of agreeableness, neuroticism, and openness to experience may have reached statistical significance given greater power from a larger sample size, and as such may provide further support for the existence of relationships between personality and social support behavior in the wake of stress.

Table 15. *Study 2 Affiliation Condition Post-stress Interaction Behaviors by Gender.*

|                                     | <b>Combined<br/>Mean (SD)</b> | <b>Women (n=22)<br/>Mean (SD)</b> | <b>Men (n=14)<br/>Mean (SD)</b> | <b>t-value<br/>(df=34)</b> |
|-------------------------------------|-------------------------------|-----------------------------------|---------------------------------|----------------------------|
| <b>Behavior</b>                     |                               |                                   |                                 |                            |
| <b>Ratio of Time<br/>Speaking</b>   | 0.23 (0.12)                   | 0.23 (0.13)                       | 0.21 (0.12)                     | 0.609                      |
| <b>Conversations<br/>Attempted</b>  | 5.81 (4.16)                   | 5.45 (4.47)                       | 6.36 (3.73)                     | -0.629                     |
| <b>Conversations<br/>Successful</b> | 4.61 (3.34)                   | 4.50 (3.66)                       | 4.79 (2.89)                     | -0.247                     |
| <b>Extent</b>                       | 4.58 (1.57)                   | 4.82 (1.56)                       | 4.21 (1.58)                     | 1.126                      |
| <b>Quality</b>                      | 4.69 (1.28)                   | 5.14 (1.21)                       | 4.00 (1.11)                     | 2.839**                    |
| <b>Intimacy</b>                     | 4.25 (1.86)                   | 4.59 (1.79)                       | 3.71 (1.90)                     | 1.399                      |
| <b>Stress-Relevant</b>              | 0.97 (0.94)                   | 0.95 (0.95)                       | 1.00 (0.96)                     | -0.139                     |
| <b>Evaluative</b>                   | 0.67 (0.83)                   | 0.68 (0.84)                       | 0.64 (0.84)                     | 0.136                      |
| <b>Factual</b>                      | 0.31 (0.47)                   | 0.27 (0.46)                       | 0.36 (0.50)                     | -0.523                     |
| <b>Language Use</b>                 |                               |                                   |                                 |                            |
| <b>Word Count</b>                   | 711.7 (499.1)                 | 752.4 (583.2)                     | 647.7 (337.8)                   | 0.608                      |
| <b>I</b>                            | 7.40 (2.46)                   | 7.30 (2.55)                       | 7.57 (2.40)                     | -0.320                     |
| <b>We</b>                           | 0.81 (0.62)                   | 0.73 (0.51)                       | 0.95 (0.76)                     | -1.039                     |
| <b>You</b>                          | 2.66 (1.73)                   | 2.33 (0.96)                       | 3.19 (2.46)                     | -1.490                     |
| <b>Positive Emotion</b>             | 3.19 (1.42)                   | 3.18 (1.16)                       | 3.20 (1.80)                     | -0.025                     |
| <b>Negative Emotion</b>             | 2.43 (0.95)                   | 2.51 (0.84)                       | 2.30 (1.11)                     | 0.660                      |
| <b>Assents</b>                      | 3.42 (1.99)                   | 4.07 (2.07)                       | 2.39 (1.38)                     | 2.931**                    |
| <b>LSM</b>                          | 0.86 (0.08)                   | 0.87 (0.07)                       | 0.84 (0.10)                     | 1.088                      |

*Note: † p < .10, \* p < .05, \*\* p < .01.*

Table 16. *Study 2 Correlations of Affiliation Condition Post-stress Interaction Behaviors by Personality.*

|                                                                                | <b>Ext</b> | <b>Agr</b> | <b>Con</b> | <b>Neur</b> | <b>Open</b> |
|--------------------------------------------------------------------------------|------------|------------|------------|-------------|-------------|
| <b>Behavior</b>                                                                |            |            |            |             |             |
| <b>Ratio of Time Speaking Conversations Attempted Conversations Successful</b> | -0.03      | 0.12       | 0.23       | -0.16       | 0.07        |
| <b>Extent</b>                                                                  | 0.07       | 0.25       | 0.33*      | -0.14       | 0.09        |
| <b>Quality</b>                                                                 | 0.32*      | 0.34*      | 0.27       | -0.02       | 0.05        |
| <b>Intimacy</b>                                                                | 0.14       | 0.18       | 0.40*      | -0.09       | -0.02       |
| <b>Stress-Relevant</b>                                                         | 0.21       | 0.17       | 0.11       | -0.38*      | 0.23        |
| <b>Evaluative</b>                                                              | 0.19       | 0.20       | 0.12       | -0.38*      | 0.10        |
| <b>Factual</b>                                                                 | 0.11       | -0.01      | 0.01       | -0.10       | 0.28†       |
| <b>Language Use</b>                                                            |            |            |            |             |             |
| <b>Word Count</b>                                                              | -0.04      | 0.18       | 0.20       | -0.17       | 0.17        |
| <b>I</b>                                                                       | 0.01       | 0.36*      | 0.29†      | -0.39*      | -0.05       |
| <b>We</b>                                                                      | 0.12       | 0.02       | 0.23       | -0.48**     | -0.09       |
| <b>You</b>                                                                     | -0.05      | -0.24      | -0.24      | 0.22        | -0.15       |
| <b>Positive Emotion</b>                                                        | -0.26      | -0.03      | -0.07      | 0.11        | 0.16        |
| <b>Negative Emotion</b>                                                        | 0.04       | 0.12       | -0.04      | 0.11        | 0.27        |
| <b>Assents</b>                                                                 | -0.14      | -0.04      | -0.01      | 0.45**      | -0.13       |
| <b>LSM</b>                                                                     | -0.02      | 0.17       | 0.04       | -0.04       | 0.09        |

Note: †  $p < .10$ , \*  $p < .05$ , \*\*  $p < .01$ . Correlations presented above reflect  $n=36$  participants.

**Question 4: Under conditions when social affiliation with a trusted friend is available, which features of social support behavior are related to physiological recovery from acute stress?**

First, in order to understand how the amount of social affiliation with a trusted friend was related to stress physiology, the role of the ratio of the amount of time the participants spoke during the recording time was assessed. The ratio of time speaking was significantly positively correlated with post-stress CORT response at time 3, which reflects CORT levels immediately preceding the interaction period ( $r = 0.32, p = .05$ ). This finding indicates that individuals with higher time 3 CORT stress levels immediately following the stressor tended to interact more with their friend than those with lower time 3 CORT responses to the stressor.

Next, the role of features of social support behavior and language were investigated to determine their potential influence on recovery of CORT levels at time 4. Partial correlations between post-stress time 4 CORT levels controlling for baseline CORT levels and each social support behavior and language use measure were performed for both participants' social support behavior (Table 17) and the social support behavior of their friends (Table 18).

Of the social support behaviors, only one was significantly related to CORT recovery at time 4 controlling for baseline CORT levels. The number of factual stressor-relevant conversations was significantly positively associated with higher CORT levels at time 4 ( $r = 0.35, p < .05$ ), and in other words, poorer CORT recovery. None of the

behavioral measures of social support provided by participants' friends were significantly correlated with participant time 4 CORT levels.

Although none of the measures of participants' language use were significantly correlated with CORT recovery at time 4, markers of social support in friends' language use were significantly correlated with participant CORT recovery at time 4. In particular, lower friend word count ( $r = 0.31, p < .10$ ) and higher friend use of the word "you" ( $r = -0.28, p < .10$ ) were each related with lower participant time 4 CORT levels controlling for baseline CORT (see Table 18).

Taken together, these findings indicated that greater word counts during the post-stress interaction by participants or their friends were not beneficially related to recovery from a stressor, and may have been a result of greater stress response at time 3 (as noted previously). Because participants with higher post-stress time 3 CORT levels had higher word counts during post-stress interactions, it follows that they appear to be the participants seeking the most social contact. Notably, because factual stressor-relevant conversations were also related to poorer recovery, it seems that discussing the stressor may have impeded recovery in this case. Finally, it appears that language use of participants' friends was related to better recovery from the stressor when the friends spoke less and tended to use the word "you" more, indicating a focus on their friend.

Table 17. *Study 2 Partial correlations of Affiliation Condition Post-stress Interaction Participant Behaviors by Time 4 CORT level controlling for Baseline CORT.*

|                                 | <b>CORT<br/>T4</b> |                         | <b>CORT<br/>T4</b> |
|---------------------------------|--------------------|-------------------------|--------------------|
| <b>Behavior</b>                 |                    | <b>Language Use</b>     |                    |
| <b>Ratio of Time Speaking</b>   | 0.15               | <b>Word Count</b>       | 0.24               |
| <b>Conversations Attempted</b>  | -0.10              | <b>I</b>                | -0.01              |
| <b>Conversations Successful</b> | -0.14              | <b>We</b>               | -0.08              |
| <b>Extent</b>                   | 0.18               | <b>You</b>              | -0.11              |
| <b>Quality</b>                  | 0.06               | <b>Positive Emotion</b> | -0.08              |
| <b>Intimacy</b>                 | 0.01               | <b>Negative Emotion</b> | -0.19              |
| <b>Stress-Relevant</b>          | 0.26               | <b>Assents</b>          | -0.23              |
| <b>Evaluative</b>               | 0.08               | <b>LSM</b>              | 0.10               |
| <b>Factual</b>                  | 0.35*              |                         |                    |

*Note: † p < .10, \* p < .05, \*\* p < .01. Correlations presented above reflect n=36 participants.*

Table 18. *Study 2 Partial correlations of Affiliation Condition Post-stress Interaction Friend Behaviors by Time 4 CORT level controlling for Baseline CORT.*

|                                 | <b>CORT<br/>T4</b> |                         | <b>CORT<br/>T4</b> |
|---------------------------------|--------------------|-------------------------|--------------------|
| <b>Behavior</b>                 |                    | <b>Language Use</b>     |                    |
| <b>Ratio of Time Speaking</b>   | 0.24               | <b>Word Count</b>       | 0.31†              |
| <b>Conversations Attempted</b>  | -0.14              | <b>I</b>                | 0.06               |
| <b>Conversations Successful</b> | -0.19              | <b>We</b>               | -0.10              |
| <b>Extent</b>                   | 0.18               | <b>You</b>              | -0.28†             |
| <b>Quality</b>                  | 0.21               | <b>Positive Emotion</b> | -0.23              |
| <b>Intimacy</b>                 | 0.22               | <b>Negative Emotion</b> | -0.08              |
|                                 |                    | <b>Assents</b>          | -0.03              |

*Note: † p < .10, \* p < .05, \*\* p < .01. Correlations presented above reflect n=36 participants and n=36 friends.*

## **SUMMARY**

Overall, the results of study 2 indicated that the availability of affiliation with a trusted friend appeared to have a protective effect on stress physiology across each time point. There was also a main effect of gender on stress physiology, with men demonstrating higher CORT levels across each time point compared to women. Further, extraversion, conscientiousness, and openness to experience each appear to be important predictors of the effect of availability of affiliation with a close friend on stress physiology over time. Personality also appears to play a role in determining to what extent individuals will engage in social support behaviors. In particular, participants higher in conscientiousness tended to demonstrate greater extent, quality, and intimacy of social interactions in the wake of a stressor. Finally, lower word count and greater “you” usage by participants’ friends were each significantly related to better participant CORT recovery from acute stress.

## **DISCUSSION**

The major aim of this dissertation was to identify and examine potential person by situation effects on stress physiology. In particular, two studies were conducted to evaluate the role of individual difference factors of gender and personality (i.e., person effects) and the availability of affiliation with a similar other (study 1) or a trusted friend (study 2) compared with no available affiliation (i.e., social situation effects) on stress response and recovery. In the following discussion, I highlight the important findings from the research questions in each study and their greater implications. Finally, I conclude with a general discussion of the collective importance of both dissertation studies in elucidating psychological factors influencing human stress physiology.

### **Study 1**

This study sought to test whether the availability of affiliation with a similar other in the wake of a stressor would have a beneficial influence on stress physiology compared to the absence of affiliation. Further, we investigated whether the role of affiliation on stress response and recovery varied based on individual difference characteristics of gender and personality traits.

First, we predicted that the availability of affiliation with a similar other would produce beneficial buffering effects on stress physiology. Contrary to our hypothesis, our findings indicated that participants who were roomed with another participant demonstrated blunted stress responses, with higher stress levels at the beginning and end

of the study compared to participants who roomed alone. One explanation for this finding is that the similar other affiliation group in general may have offered negative social comparison, and thus may have served as an unintended and continuous additional feature of the stressor (Dickerson & Kemeny, 2004).

Next, we investigated the existence of person by situation effects on stress physiology. Gender has been implicated as a critical individual difference factor in the extent to which affiliation and social support influence stress response and recovery, as stress physiology among women has been theorized to benefit more from social affiliation than among men (Taylor, et al., 2000; Taylor & Master, 2011). The current study failed to find support for this model, instead finding that the influence of affiliation did not depend on gender alone. Rather, the combined relationship of personality traits and gender accounted for individual differences in the effect of affiliation on stress physiology. Lower openness to experience contributed to greater CORT stress response in the presence of another participant compared to being alone. This individual difference may have been due in part to the unusual environment of being roomed with a stranger, as low openness to experience has been related to greater stress in response to with novel experiences (Williams, et al., 2009). Thus, trait-level comfort with novel experiences may play a central role in unfamiliar laboratory stress paradigms in particular.

Subsequently, we sought to understand the role of individual differences in social support behavior after a stressor, and how those differences may impact recovery from acute stress. Interestingly, and in contrast to our expectations, there was a general

absence of social support interactions in this study. A surprising number of participants (over 58%) who had a similar other available to affiliate with instead sat in silence during the entire 20 minute period immediately following in the stressor. Personality, and not gender, was shown to be an important factor in determining to what extent individuals engaged in greater social support behaviors with a similar other in the wake of a stressor, which in turn were related to better recovery from the stressor. Higher openness to experience was related to greater extent, quality, and intimacy, and even overall word count during similar other dyadic interactions, and suggests that trait-level comfort with novel experiences may be a key factor in experimental social support research as well. As such, personality in general, and openness to experience more specifically, are an essential consideration in stress and social support research that has been largely overlooked (Marshall, Wortman, Vickers, Kusulas, & Hervig, 1994; Oswald, et al., 2006; Uchino & Birmingham, 2011).

Taken together, the findings from study 1 support the existence of important individual difference factors in understanding the situational effects of affiliation with a similar other on stress physiology. Furthermore, gender alone does not appear to account for differences in who benefits from social support with a similar other in the wake of a stressor, and instead was only related to stress physiology in connection with the influence of personality traits. Rather, this study argues for the inclusion of personality characteristics in models of physiological stress response, and in stress and social support research, generally.

## Study 2

Building from study 1, this study sought to examine the effect of social support on stress physiology from a more trusted source—a close friend. We were interested in whether the availability of affiliation with a trusted friend in the wake of a stressor would have a beneficial influence on stress physiology compared to the absence of affiliation. Again, we investigated whether the role of affiliation on stress response and recovery varied based on individual difference characteristics of gender and personality traits.

We hypothesized that the availability of affiliation with a trusted friend would provide a buffering effect against a physiological response to stress. The buffering hypothesis was supported in this study, as there was a significant effect of condition on stress response over each time point sampled. Specifically, participants who had a friend with them for the duration of the study did not appear to demonstrate a stress response, on average, compared to participants who roomed alone. This finding fits with the existing research in the social support literature that has shown an attenuation of stress reactivity as a result of social support in the laboratory (Thorsteinsson & James, 1999). One alternative explanation for the failure of participants in the affiliation condition as a whole to demonstrate stress responses could be attributed to a failure of random assignment that may have led to characteristic differences in the group's sensitivity to stress. However, this seems highly implausible given that our results suggested no differences in characteristic trait-level anxiety by condition, or any other demographic and individual difference characteristics for that matter.

Next, we turned our attention to whether individual differences were present in the extent to which the availability of affiliation influences physiological response to stress. In this study, we found a main effect of gender in predicting stress physiology, irrespective of time or the presence of a friend. Generally, men demonstrated higher CORT overall compared to women, which replicates past research showing gender differences in HPA-axis reactivity (Kirschbaum, et al., 1999; Kirschbaum, Wust, & Hellhammer, 1992). Because the effect of gender on stress physiology did not vary by affiliation condition, the current study did not find support for the tend-and befriend model, which theorizes differential effects of affiliation on stress based on gender.

However, our findings instead revealed individual differences in the effect of affiliation with a friend on stress physiology based on personality traits. Further, personality traits, together with the main effect of gender, accounted for individual differences in the effect of affiliation on stress physiology. Conscientiousness and openness to experience each appear to be important predictors of the effect of availability of affiliation with a close friend on stress physiology over time. Both men and women in the presence of a friend who were lower in openness to experience showed a buffering effect, with lower CORT levels compared to those higher in openness to experience, who had elevated CORT across time. This finding is consistent a previous study that found higher openness to experience was related to greater HPA-axis response (Oswald, et al., 2006).

Although there were no robust stress responses evident the affiliation condition overall, openness to experience did predict higher CORT levels at each time point within

this condition. Notably, the lowest CORT values, and strongest buffering effects, were observed among participants lower in openness to experience roomed with a friend. Also, with regard to patterns across time, the expected pattern of robust HPA-axis response to stress was seen only among the lower openness solo condition participants. This finding may indicate that those participants not comfortable with novel experiences may have been primed to respond to the acute stressor, and they did not have access to the beneficial buffering effect of affiliation with a trusted friend. This explanation is in line with the view of openness to experience as a marker of trait-level comfort with novel experiences that past research has argued, and the role of low openness to experience in stress vulnerability (Williams, et al., 2009; Williams, et al., 2010). Also, taken together, the existence of above person by situation effects further refutes the failure of random assignment explanation, and instead supports a person by situation stress buffering model.

Consequently, we sought to understand the role of individual differences in social support behavior after a stressor, and how those differences may impact recovery from acute stress. Firstly, personality appears to play a role in determining to what extent individuals will engage in social support behaviors. In particular, participants higher in conscientiousness tended to have greater, higher quality, and more intimate dyadic interactions with their friend in the wake of a stressor, which may explain the individual difference effects relating conscientiousness to stress physiology.

Also, social support behaviors such as greater “you” usage by participants’ friends and lower word count were each significantly related to better participant recovery from

acute stress. These findings suggest that a greater focus on the participant (as signified by “you” by friends), and perhaps less ruminating (i.e., lower word counts) benefits participants. This explanation fits with recent research noting the harmful effects of rumination with a friend (Byrd-Craven, Geary, Rose, & Ponzi, 2008), as well as the benefits of invisible support, or support that is not explicit in its provision (e.g., distraction from the stressor, or even support expressed to a third party while the participant watches on) on stress physiology (Bolger & Amarel, 2007; Bolger, Zuckerman, & Kessler, 2000; Howland & Simpson, 2010; Uchino & Birmingham, 2011).

In sum, the findings from study 2 support the existence of important individual difference factors in the understanding the situational effects of affiliation with a trusted friend on stress physiology. While individual differences in the beneficial effects of affiliation and social support on stress were not attributable to gender, personality did appear to account for these differences. These findings suggest that models of stress physiology and the stress-support relationship should include individual difference characteristics of personality.

## **General Discussion**

Across two studies, we found evidence for person by situation effects on stress physiology. In both studies, the effect of the availability of affiliation with either a similar other or a trusted friend compared to being alone differed based on individual difference factors of personality. Neither study found support for the hypothesis that the effects of affiliation availability after stress depend on gender, rather both studies found

support for the hypothesis that the role of affiliation and social support on stress physiology depends instead on personality characteristics. As such, the tend-and-befriend model of stress response may be better conceptualized not as a uniquely female response, but rather a stress response that depends on individual difference characteristics of personality. In other words, the benefits of affiliation and social support were not different among men compared to women, whereas personality traits were able to predict which participants would benefit from affiliation and social support in the wake of a stressor.

Further, because individual differences in the stress response were evident across both studies, our findings appear to suggest that the one-size-fits-all approach of the fight-or-flight model of stress physiology as it is now may also benefit from revision to account for individual differences in reactivity, as other theorists have suggested (Taylor, et al., 2000; Taylor & Master, 2011).

One major difference found in comparing the findings from study 1 to study 2 was the difference in the extent to which participants engaged in social support behaviors specifically, and any social contact more generally. In study 1, not only was there a relative absence of affiliation with a similar other, there was no overall buffering effect of the similar other affiliation condition evident on stress physiology. On the other hand, study 2 found a significant buffering effect of affiliation with a trusted friend on stress physiology compared with being alone. This striking difference between the results found across the current studies may be explained by past research that has shown stranger support in general is not as effective as friend support (Christenfeld et al., 1997).

There are some obvious limitations in the current studies that merit discussion here. First and foremost, the design of study 2 as a follow-up to the first did not test all three affiliation conditions in this dissertation simultaneously (no affiliation available, similar other affiliation available, and friend affiliation available). Due to feasibility constraints, study 2 did not retain a stranger affiliation condition as was included in study 1, which prevents us from drawing statistical comparisons between the two studies and with them the two affiliation available conditions. It would be ideal to have no affiliation, similar other, and trusted friend affiliation all in one study to allow for statistical comparisons of the individual differences found across the two studies in the effects of affiliation on stress physiology. Another limitation of the current research was that we did not anticipate the tremendous lack of dyadic interaction among the affiliation group in study 1. As such, due to this relative absence, the sample size needed would have to be much larger to capture enough affiliation and social support behavior to power statistical tests.

Despite these limitations, the current research contributes greatly to what is known about individual differences in stress physiology and the stress-support relationship. We acknowledge that it is highly speculative to draw conclusions about the potential role of the interaction of personality and social support effects on health based solely on the person by situation effects demonstrated on stress physiology in the current studies. However, there is reason to suspect that these individual differences in the role of social support may extend beyond stress physiology to general health outcomes and processes based on epidemiological studies that have found both links between social

support and health outcomes (Cohen, 1988), as well as personality traits and health outcomes (Jonassaint, et al., 2007). By assuming a person by situation approach to the study of stress physiology and in health psychology research generally, we may make meaningful advances in understanding and better predicting broad health outcomes.

Future research would benefit from the exploration of the role of individual difference factors of personality—particularly openness to experience—in stress research, especially when measuring social support interactions, as this important relationship replicated across both of the current studies.

## **Appendix A: Modified Trier Social Stress Test Materials**

### **Instructions for Experimenter**

**Stress Task.** [First, make sure that the Judge is seated and waiting in a lab coat, with a clipboard. Make sure that the Judge has their script. You will be bringing each participant in one at a time to read them the following instructions in front of the judge. After that point, you will give each participant 5 minutes to prepare their speech, then you will bring each subject in for 5 minutes exactly.]

Read to participant in speech room in front of Judge:

**“Next we’re going to have you deliver a speech defending yourself from an allegation of theft to this Judge. Your speech will be evaluated based on your creativity, intelligence, logic and convincingness. This judge is carefully trained to analyze the verbal and non-verbal contents of your speech. You will be videotaped so that the evaluator can carefully review each of these aspects of your speech. You should try to do better than all of the other participants and be as creative and convincing as possible. Once given the situation describing the allegation of theft, you will have 5 minutes to prepare your speech after which time, you will be brought back to this room to deliver your speech. Okay, if you have no questions, I will give you the situation and your time will begin.”**

[Take the participant to their seat in the original room and give them a printout of **Situation for Speech to Judge**. Set the stopwatch for 5 minutes. When the time is up, bring them to the Judge, and do not allow them to bring and notes/props. Make sure that the video camera appears on and aimed at participant for each participant's speech.]

## Instructions for Judge

You should be neatly dressed and appear as a real examiner. Keep a pad and pen for pretending to take notes. Keep a neutral face throughout the session when the subject is in the room. As soon as the instructor leaves the room, start the timer. You should wait for the subject to start the defense without any prompting. If the subject has not started the task in 30 seconds, just make a simple prompt, "Please start." At regular intervals, pretend to take notes (this should be done at approximately 1-minute intervals and the comments should be brief so that your eyes are not off the participant for more than a glance). Once the subject begins the task, let him/her continue until the 5-minute duration. Then instruct the subject, "**Please stop, your time is up.**" If a subject finishes the task in less than 5 minutes, ask him/her to continue, "**You still have some time. Please continue.**" Give up to 10-15 seconds before making such prompts. If the subject asks any other questions make neutral comments, such as, "**Do whatever you think is best,**" "**Say whatever comes to your mind,**" "**Be as creative as you like.**"

At the end of 5 minutes, instruct the subject, "**Please stop, your time is up. You can go back to your room now.**" (Note: if the subject asks questions as to how he/she did, please say that you are not allowed to tell. "Someone will give you that information later.")

If at any time the subject appears to be having an adverse reaction, i.e. begins to cry or seems overly agitated, you must ask the subject, “Are you okay?” “Do you want to stop?” “Are you okay to continue?” If the subject indicates that they wish to stop, stop immediately and notify the researcher that the participant has had an adverse reaction and needs to be debriefed.

## **Instructions for Participant**

### **SITUATION FOR SPEECH TO JUDGE**

You are leaving a department store when two security officers stop you. They ask to search the grocery bag that you're carrying, as there is some suspicion that you may have taken an item. When they search the bag, they find a \$200 watch in the bag along with the grocery items that you purchased at another store. The price tag is on the watch and shows that it is from the department store. The police are called and because this appears to be your first offense, you are not arrested but are charged with theft and you are told that you will need to appear in court.

## Appendix B: Timeline of Study 1 and 2 Procedures

### Study Conditions:

Two Conditions in BOTH Study 1 and 2:

- 1) Solo (roomed alone)  
OR
- 2) Affiliation (roomed in same-sex dyad):
  - Study 1: Two participants— each completing stressful task
  - Study 2: Participant and a trusted, platonic, same-sex friend— only the participant completes stressful task

### Timeline of Procedures:

| <u>Elapsed Time</u> | <u>Action</u>                                                                                                           |
|---------------------|-------------------------------------------------------------------------------------------------------------------------|
| 0:00                | Consenting participants, then begin questionnaires<br><i>Packet included: Background Questionnaire, STAI-Trait, BFI</i> |
| 0:20                | <b>Physiological sample #1</b>                                                                                          |
| 0:30                | Modified Trier Social Stress Test                                                                                       |
| 0:40                | <b>Physiological sample #2</b><br><i>Administer STAI-State</i>                                                          |
| 0:45                | <i>Affiliation condition only:</i><br><i>*TURN CAMERA ON*</i>                                                           |
| 0:60                | <b>Physiological sample #3</b><br><i>Affiliation condition only:</i><br><i>*TURN CAMERA OFF*</i>                        |
| 0:80                | <b>Physiological sample #4</b>                                                                                          |
| 0:90                | Debrief and Thank Participants                                                                                          |





14. Do you have any untreated endocrine disease? YES NO

If yes, please provide details \_\_\_\_\_

15. In the past hour have you done any of the following.

Had anything to eat? YES NO

Had anything to drink besides water? YES NO

Had a cigarette? YES NO

Brushed your teeth? YES NO

16. How much did you feel happy, excited, or content when you woke up?

1 2 3 4 5 6 7  
Not at all Average Extremely

17. How much did you feel worried, anxious, or fearful when you woke up?

1 2 3 4 5 6 7  
Not at all Average Extremely

18. Have you engaged in any vigorous exercise today? Y N

If yes, please describe type and duration of exercise \_\_\_\_\_

\_\_\_\_\_

19. What time do you usually wake up on weekdays?

\_\_\_\_\_

20. What time did you wake up today?

\_\_\_\_\_

**Women only**

1. What is the normal length of your menstrual cycle in days, from the first day of one menstrual period to the first day of the next menstrual period? \_\_\_\_\_

2. How regular are your menstrual cycles in their time of onset? (Please circle one)

# perfectly regular

# varies by 1-2 days

# varies by 3-4 days

# varies by 5-6 days

# varies by 7 days or more

# completely unpredictable

3. Are you pregnant or breast-feeding an infant at present?      YES      NO

4. Do you ever go through long periods of time without having menstrual periods (for reasons other than pregnancy)?      YES      NO

    If yes, has this happened in the last 12 months?      YES      NO

5. Are you currently menstruating?      YES      NO

    If yes, what date did your current period begin? \_\_\_\_\_

    If no, what date did your last period begin? \_\_\_\_\_

**STAI – State:**

A number of statements which people have used to describe themselves are given below. Read each statement and then check the appropriate box to the right of the statement to indicate how you feel right now, that is, *at this moment*. There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe your present feelings best.

|                                                      | <i>Not at all</i>        | <i>Somewhat</i>          | <i>Moderately so</i>     | <i>Very much so</i>      |
|------------------------------------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| 1. I feel calm                                       | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 2. I feel secure                                     | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 3. I am tense                                        | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 4. I feel strained                                   | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 5. I feel at ease                                    | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 6. I feel upset                                      | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 7. I am presently worrying over possible misfortunes | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 8. I feel satisfied                                  | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 9. I feel frightened                                 | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 10. I feel comfortable                               | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 11. I feel self-confident                            | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 12. I feel nervous                                   | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 13. I am jittery                                     | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 14. I feel indecisive                                | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 15. I am relaxed                                     | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 16. I feel content                                   | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 17. I am worried                                     | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 18. I feel confused                                  | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 19. I feel steady                                    | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 20. I feel pleasant                                  | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

**STAI – Trait:**

| A number of statements which people have used to describe themselves are given below. Read each statement and then check the appropriate box to the right of the statement to indicate how you <i>generally</i> feel. There are no right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe your present feelings best. | Almost never             | Sometimes                | Often                    | Almost always            |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
|                                                                                                                                                                                                                                                                                                                                                                                    |                          |                          |                          |                          |
| 21. I feel pleasant                                                                                                                                                                                                                                                                                                                                                                | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 22. I feel nervous and restless                                                                                                                                                                                                                                                                                                                                                    | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 23. I feel satisfied with myself                                                                                                                                                                                                                                                                                                                                                   | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 24. I wish I could be as happy as others seem to be                                                                                                                                                                                                                                                                                                                                | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 25. I feel like a failure                                                                                                                                                                                                                                                                                                                                                          | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 26. I feel rested                                                                                                                                                                                                                                                                                                                                                                  | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 27. I am "calm, cool, and collected"                                                                                                                                                                                                                                                                                                                                               | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 28. I feel that difficulties are piling up so that I cannot overcome them                                                                                                                                                                                                                                                                                                          | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 29. I worry too much over something that really doesn't matter                                                                                                                                                                                                                                                                                                                     | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 30. I am happy                                                                                                                                                                                                                                                                                                                                                                     | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 31. I have disturbing thoughts                                                                                                                                                                                                                                                                                                                                                     | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 32. I lack self-confidence                                                                                                                                                                                                                                                                                                                                                         | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 33. I feel secure                                                                                                                                                                                                                                                                                                                                                                  | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 34. I make decisions easily                                                                                                                                                                                                                                                                                                                                                        | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 35. I feel inadequate                                                                                                                                                                                                                                                                                                                                                              | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 36. I am content                                                                                                                                                                                                                                                                                                                                                                   | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 37. Some unimportant thought runs through my mind and bothers me                                                                                                                                                                                                                                                                                                                   | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 38. I take disappointments so keenly that I can't put them out of my mind                                                                                                                                                                                                                                                                                                          | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 39. I am a steady person                                                                                                                                                                                                                                                                                                                                                           | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |
| 40. I get in a state of tension or turmoil as I think over my recent concerns and interests                                                                                                                                                                                                                                                                                        | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |

### **Big Five Inventory:**

Here are a number of characteristics that may or may not apply to you. For example, do you agree that you are someone who likes to spend time with others? Please write a number next to each statement to indicate the extent to which you agree or disagree with that statement. Answer quickly. Please do not skip any items.

| Disagree<br>strongly | Disagree a<br>little | Neither<br>disagree nor<br>agree | Agree a<br>little | Agree<br>strongly |
|----------------------|----------------------|----------------------------------|-------------------|-------------------|
| <b>1</b>             | <b>2</b>             | <b>3</b>                         | <b>4</b>          | <b>5</b>          |

#### **I see myself as someone who ...**

- |        |                                        |        |                                            |
|--------|----------------------------------------|--------|--------------------------------------------|
| ___ 01 | Is talkative                           | ___ 23 | Tends to be lazy                           |
| ___ 02 | Tends to find fault with others        | ___ 24 | Is emotionally stable, not easily upset    |
| ___ 03 | Does a through job                     | ___ 25 | Is inventive                               |
| ___ 04 | Is depressed, blue                     | ___ 26 | Has an assertive personality               |
| ___ 05 | Is original, comes up with new ideas   | ___ 27 | Can be cold and aloof                      |
| ___ 06 | Is reserved                            | ___ 28 | Perseveres until the task is finished      |
| ___ 07 | Is helpful and unselfish with others   | ___ 29 | Can be moody                               |
| ___ 08 | Can be somewhat careless               | ___ 30 | Values artistic, aesthetic experiences     |
| ___ 09 | Is relaxed, handles stress well        | ___ 31 | Is sometimes shy, inhibited                |
| ___ 10 | Is curious about many different things | ___ 32 | Is considerate and kind to almost everyone |

- |     |    |                               |     |    |                                               |
|-----|----|-------------------------------|-----|----|-----------------------------------------------|
| ___ | 11 | Is full of energy             | ___ | 33 | Does things efficiently                       |
| ___ | 12 | Starts quarrels with others   | ___ | 34 | Remains calm in tense situations              |
| ___ | 13 | Is a reliable worker          | ___ | 35 | Prefers work that is routine                  |
| ___ | 14 | Can be tense                  | ___ | 36 | Is outgoing, sociable                         |
| ___ | 15 | Is ingenious, a deep thinker  | ___ | 37 | Is sometimes rude to others                   |
| ___ | 16 | Generates a lot of enthusiasm | ___ | 38 | Makes plans and follows through with them     |
| ___ | 17 | Has a forgiving nature        | ___ | 39 | Gets nervous easily                           |
| ___ | 18 | Tends to be disorganized      | ___ | 40 | Likes to reflect, play with ideas             |
| ___ | 19 | Worries a lot                 | ___ | 41 | Has few artistic interests                    |
| ___ | 20 | Has an active imagination     | ___ | 42 | Likes to cooperate with others                |
| ___ | 21 | Tends to be quiet             | ___ | 43 | Is easily distracted                          |
| ___ | 22 | Is generally trusting         | ___ | 44 | Is sophisticated in art, music, or literature |

## Appendix D: Supplementary Results

### Study 1, Research Question 2:

**For whom is the availability of affiliation with a similar other beneficial? Are person by situation effects on stress physiology evident?**

#### *Gender as an Individual Difference Factor*

First, gender was examined as a possible individual difference factor and was added to the model testing the role of condition across time (see Table 6) as a predictor, creating the time x condition x gender interaction term, as well as underlying 2-way interactions and the main effect of gender. With gender added to the model, the time x condition x gender interaction did not significantly predict CORT response [ $F(1,166) = 0.548, p = .46$ ], nor did the underlying 2-way interactions including gender or the main effect of gender ( $p$ -values ranged from .17-.76). Because there was no effect of gender alone, the final model reduced to the model presented in Table 6.

#### *Personality as an Individual Difference Factor*

Next, each of the Big Five personality traits were assessed as potential explanations of individual differences in stress response over time. The multilevel random intercepts model of personality trait (e.g., extraversion), subsequent 2-way interactions, and the 3-way interaction of time x condition x personality trait (e.g., extraversion) was tested. Beginning with extraversion, the 3-way interaction time x

condition x extraversion did not significantly predict CORT response [ $F(1,166) = 2.002$ ,  $p = .16$ ], nor did the underlying 2-way interactions, or the main effect of extraversion ( $p$ -values ranged from .19-.87).

This process was repeated for each of the remaining Big Five personality traits. When agreeableness was included in the model as the personality trait of interest, the 3-way interaction predicting CORT response was not significant [ $F(1,166) = 0.094$ ,  $p = .76$ ], nor were the underlying 2-way interactions, or the main effect of agreeableness ( $p$ -values ranged from .41-.80). When conscientiousness was included, the 3-way interaction did not significantly predict CORT response [ $F(1,164) = 0.467$ ,  $p = .50$ ], nor did the underlying 2-way interactions, or the main effect of conscientiousness ( $p$ -values ranged from .24-.82). With the inclusion of neuroticism in the model, the 3-way interaction did not significantly predict CORT response [ $F(1,166) = 0.566$ ,  $p = .45$ ], nor did the underlying 2-way interactions, or the main effect of neuroticism ( $p$ -values ranged from .23-.83). Lastly, when openness to experience was included in the model, the 3-way interaction did not significantly predict CORT response [ $F(1,166) = 1.797$ ,  $p = .18$ ], nor did the underlying 2-way interactions, or the main effect of openness to experience ( $p$ -values ranged from .16-.66).

### **Study 2, Research Question 2:**

**For whom is the availability of affiliation with a trusted friend other beneficial? Are person by situation effects on stress physiology evident?**

### ***Gender as an Individual Difference Factor***

First, gender was examined as a possible individual difference factor and was added to the model testing the role of affiliation condition across time (see Table 14) as a predictor, creating the time x condition x gender interaction term, as well as underlying 2-way interactions and the main effect of gender. With gender added to the model, the time x condition x gender interaction did not significantly predict CORT response [ $F(1,153) = 0.599, p = .44$ ], nor did the underlying 2-way interactions including gender ( $p$ -values ranged from .33-.90). However, there was a main effect of gender in predicting CORT response regardless of time or condition [ $F(1,74) = 4.629, p = .04$ ], with men demonstrating higher CORT overall compared to women (Figure 5).

### ***Personality as an Individual Difference Factor***

Next, each of the Big Five personality traits were assessed as potential explanations of individual differences in stress response over time. A multilevel random intercepts model of personality trait (e.g., extraversion), subsequent 2-way interactions, and the 3-way interaction of time x condition x personality trait (e.g., extraversion) was tested for each trait. Each of these models also included baseline CORT as a covariate, and retained the main effect of gender because, as noted, CORT was shown to vary by gender regardless of time and condition (see Figure 5).

Beginning with extraversion, the 3-way interaction time x condition x extraversion marginally significantly predicted CORT response [ $F(1,151) = 2.675, p = .10$ ], controlling for baseline CORT and gender (Figure 6). This process was repeated for each of the remaining Big Five personality traits. When conscientiousness was tested,

the 3-way interaction significantly predicted CORT response [ $F(1,153) = 5.689, p = .02$ ; Figure 7]. When openness to experience was tested, the 3-way interaction significantly predicted CORT response [ $F(1,153) = 3.787, p = .05$ ; Figure 8].

When neuroticism was tested in the model, the 3-way interaction did not significantly predict CORT response [ $F(1,153) = 2.039, p = .16$ ], nor did the underlying 2-way interactions or the main effect of neuroticism ( $p$ -values ranged from .18-.77), with the exception of neuroticism x time [ $F(1,153) = 3.962, p = .05$ ]. The interaction of neuroticism x time indicated that neuroticism was significantly negatively related to CORT response across various time points, regardless of gender or condition (as suggested by correlations in Table 14). Lastly, when agreeableness was tested in as the personality trait of interest, the 3-way interaction predicting CORT response was not significant [ $F(1,153) = 0.197, p = .66$ ], nor were the underlying 2-way interactions, or the main effect of agreeableness ( $p$ -values ranged from .16-.99).

### ***Gender and Personality Jointly as Individual Difference Factors***

Given that personality was a significant predictor of individual differences in stress response over time between the solo vs. friend-affiliation conditions along with the main effect of gender, the two constructs were examined simultaneously to determine if the combined role of both gender and personality traits were important. As outlined above, five separate multilevel random intercepts models were examined, each including one Big Five personality trait at a time along with gender as predictors to the existing model (see Table 14) to predict CORT response. This meant that, in addition to the existing model predictors (time, condition, the covariate of baseline CORT, and the main

effect of gender), the 4-way interaction of time x condition x gender x personality trait (e.g., extraversion) and the underlying interactions and main effects were tested.

Of the five models, none of the time x condition x gender x personality trait interactions emerged to significantly predict individual differences in CORT response over time between solo vs. friend-affiliation conditions ( $p$ -values ranged from .14-.67). This indicates that although gender is an important factor, personality x condition x time interactions did not vary based on gender. Overall, these findings highlight the contributions of both gender and personality and provide support the existence of person by situation effects in stress physiology.

## Appendix E: Supplementary Figures

All eight figures presented in this dissertation utilized log-transformed CORT values (log-transformed ug/dL) as the dependent variable in each graph. This appendix reproduces the same eight figures, but instead utilizes raw (non-transformed) CORT values (ug/dL) as the dependent variable on the y-axes. All other features of the graphs are identical to the original figures presented in the text.

Figure 1.

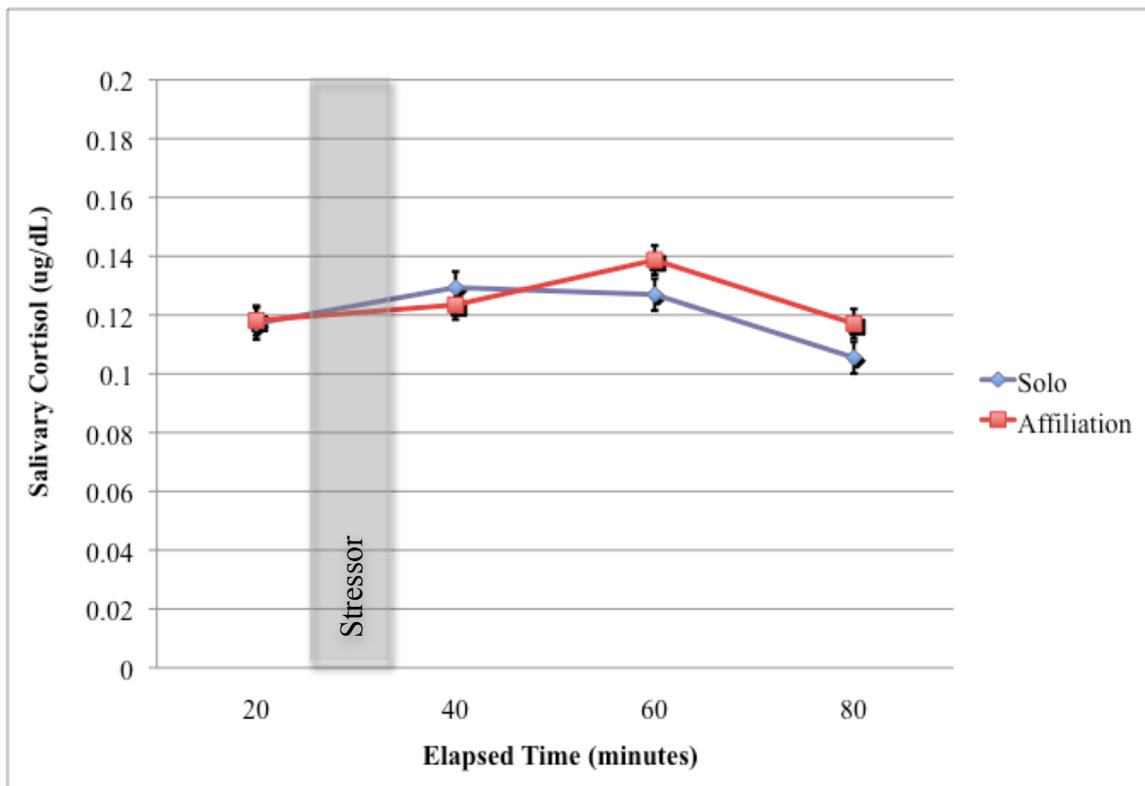


Figure 2.

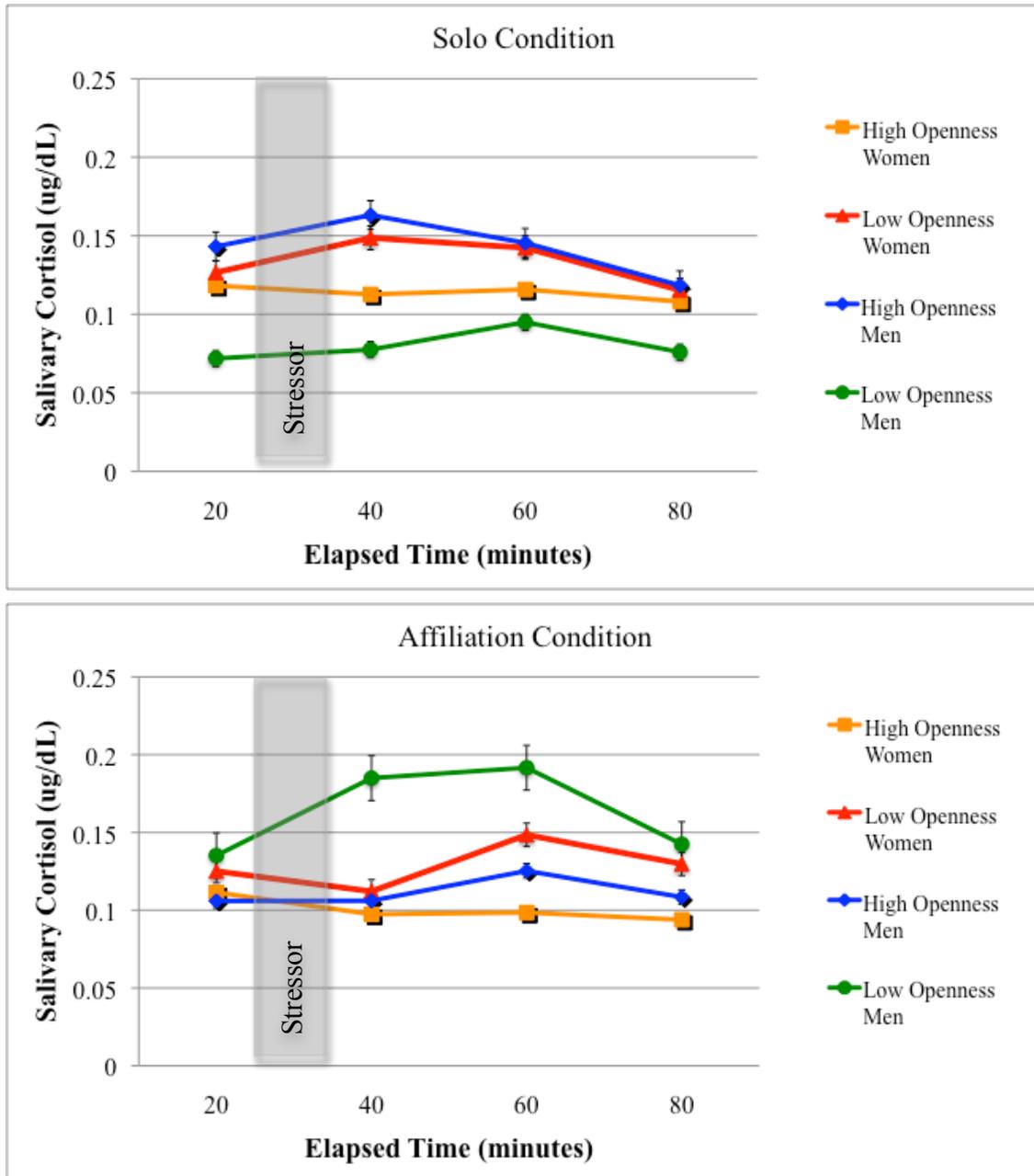


Figure 3.

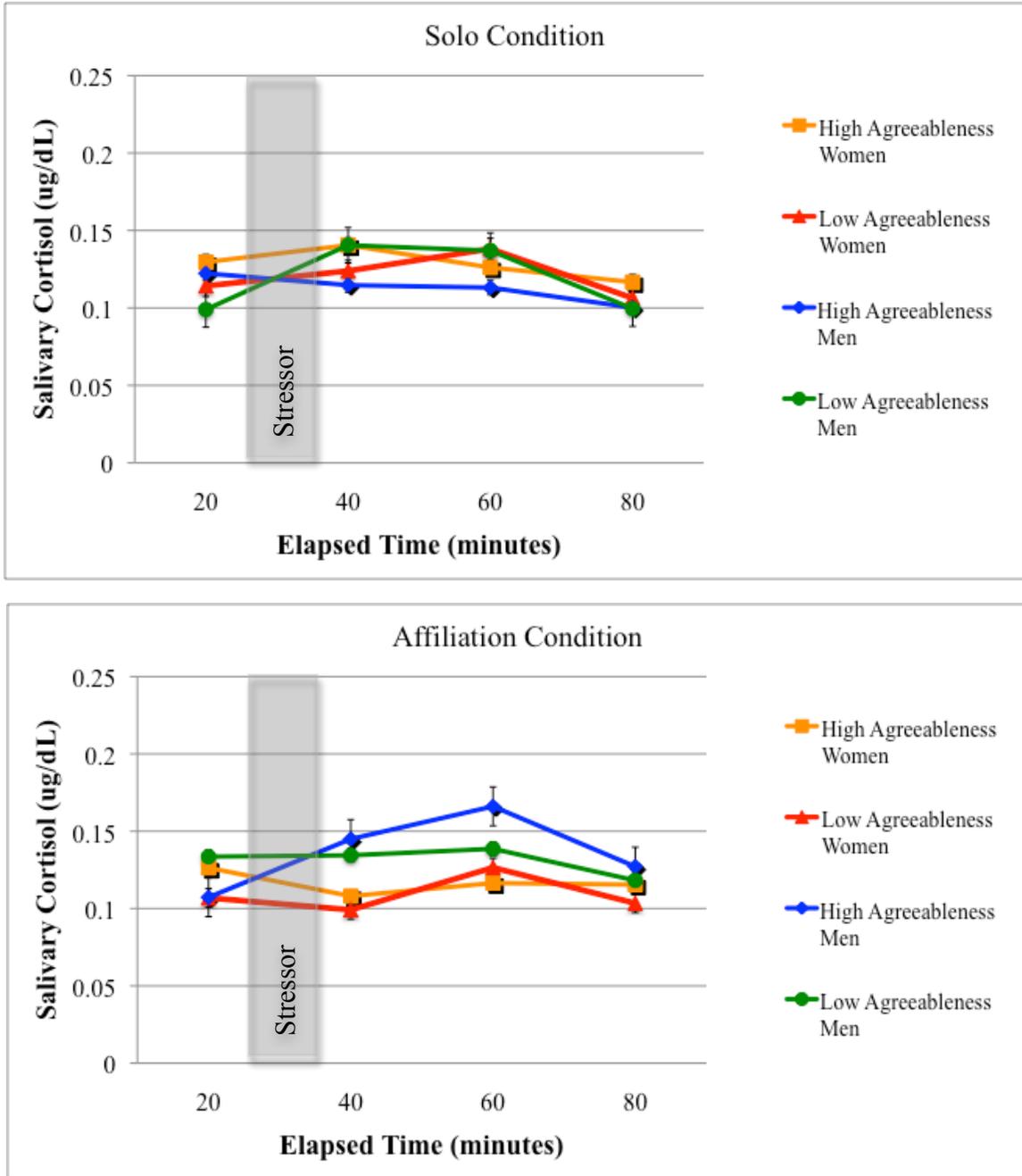


Figure 4.

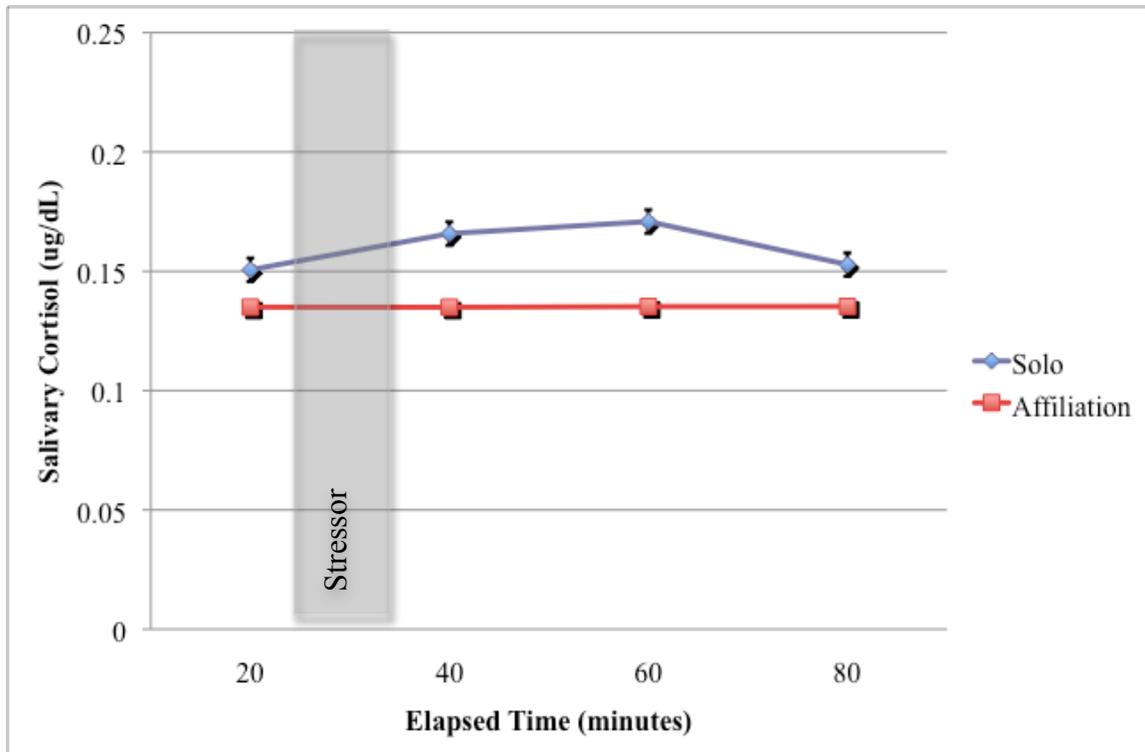


Figure 5.

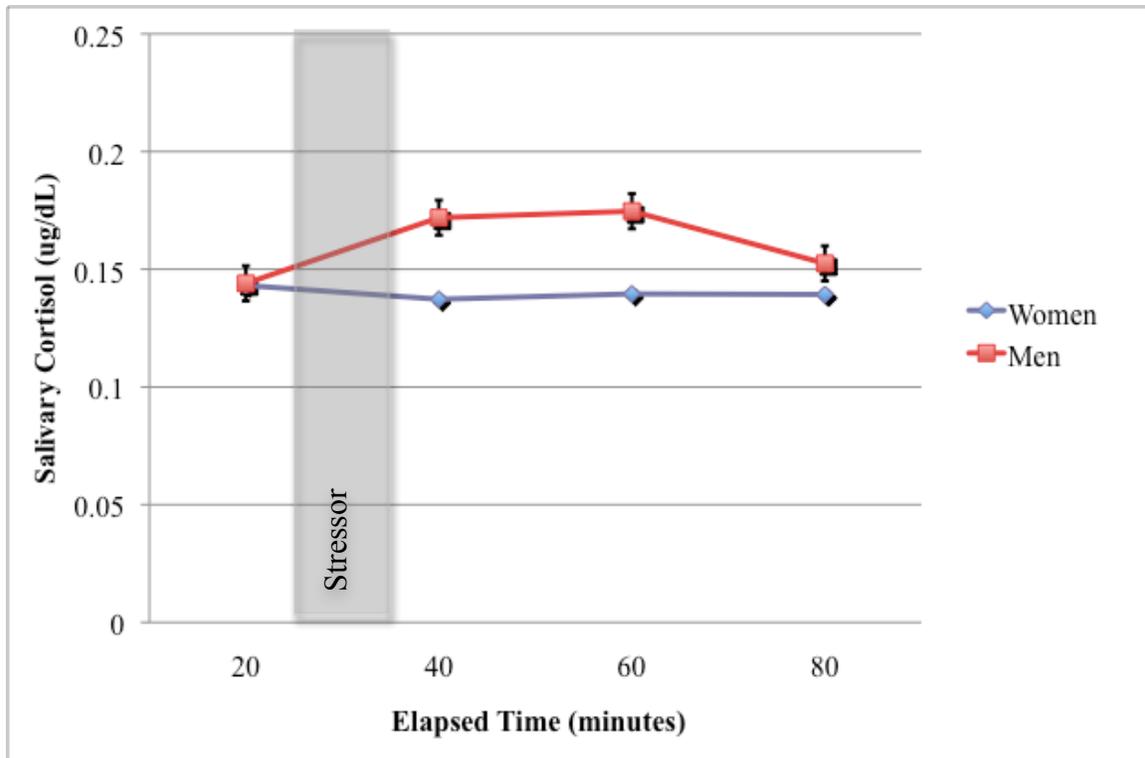


Figure 6.

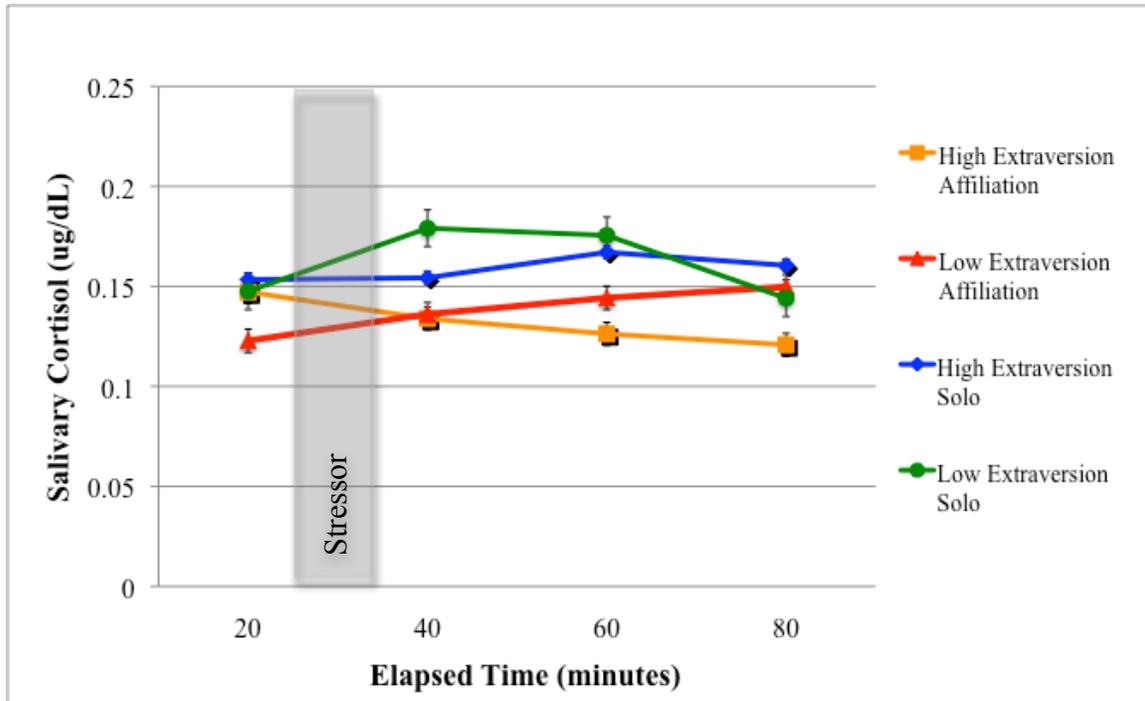


Figure 7.

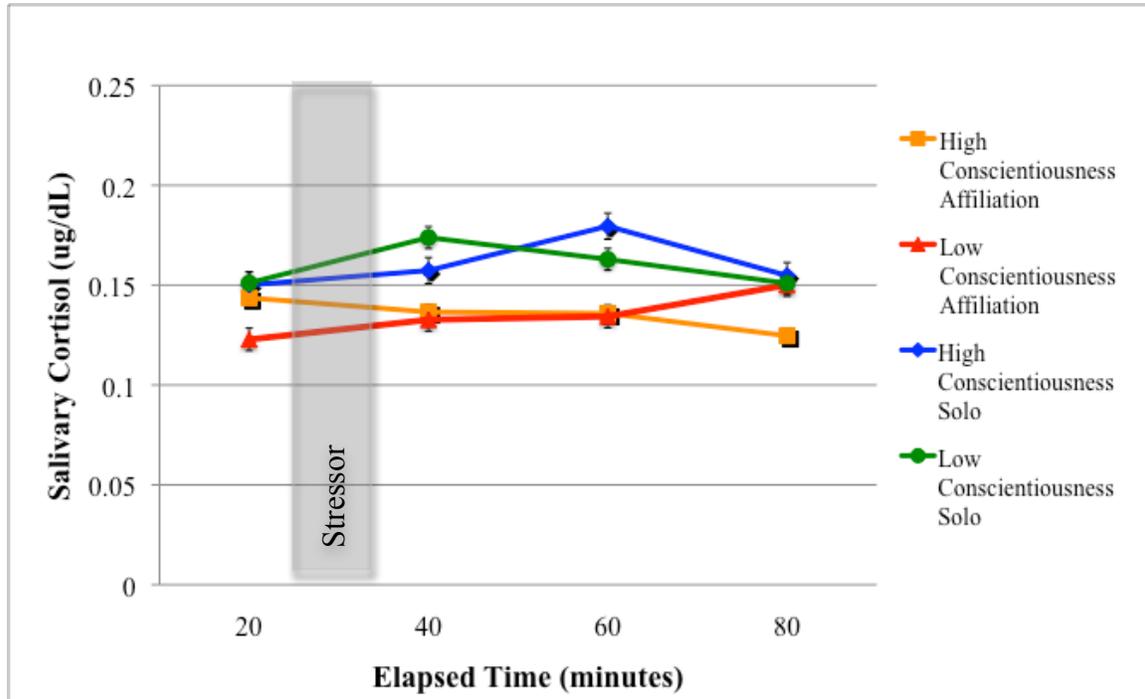
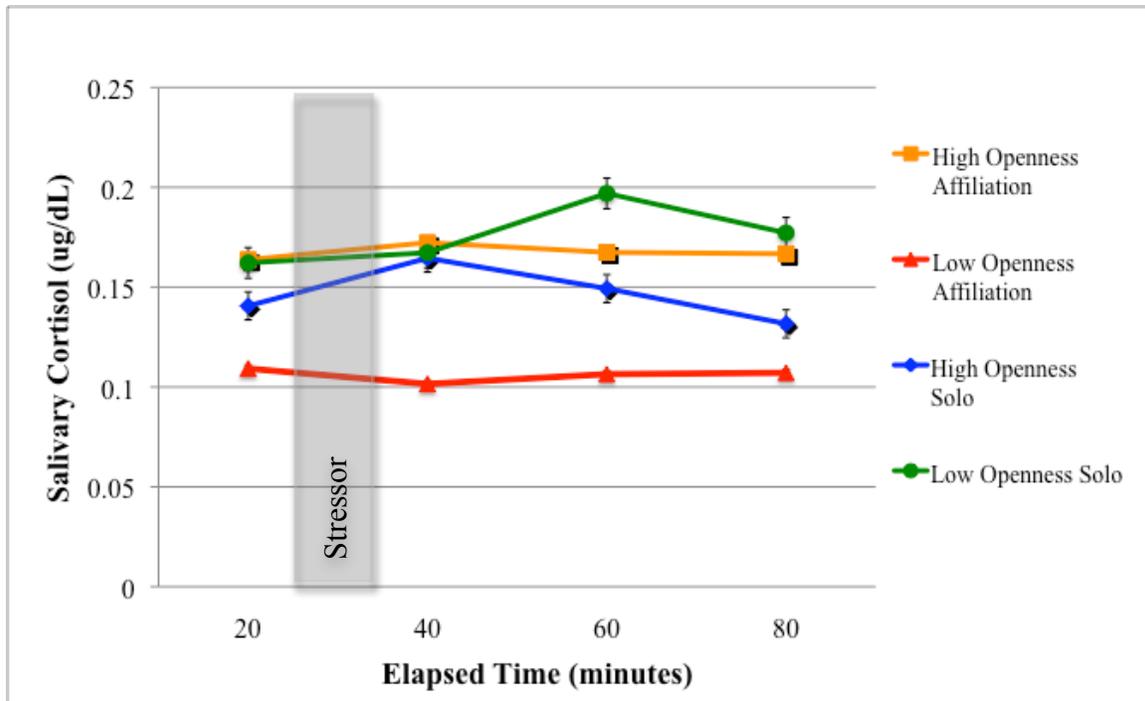


Figure 8.



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## **Personal Vita**

Jacqueline Josephine Evans was born and raised in California. After attending Harbor High School in Santa Cruz, California, she went on to earn an Associate of Arts in Psychology at Cabrillo College in Aptos, California in May, 2001 at the age of 18. Jacqueline then enrolled at University of California, Santa Cruz and in June, 2003, she graduated with a Bachelor of Arts in Psychology with Honors. Following graduation, she worked as a research assistant to Dr. Constance Hammen in the Psychology Department at University of California, Los Angeles. In May, 2004, she moved to Dallas, Texas to work as a Clinical Data Specialist in Psychiatry with Dr. Uma Rao at The University of Texas Southwestern Medical Center. She entered the doctoral program in Psychology at The University of Texas at Austin in August 2006 with Dr. Robert Josephs as her research advisor. In 2007 and 2008, she was awarded Liberal Arts Graduate Research Fellowships to support her research activities. She has also received recognition for teaching, earning the Department of Psychology Alma Carson Teaching Assistant Award in 2009, and the Janet T. Spence Teaching Award for an Assistant Instructor in 2011. After graduation, she will pursue a career in teaching and research Psychology.

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