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#### **Publication Date**

2015

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### UNIVERSITY OF CALIFORNIA

Los Angeles

Social Support across Source and Context:

Implications for Well-Being during Adolescence and Young Adulthood

A dissertation submitted in partial satisfaction of the requirements for the degree Doctor of Philosophy in Psychology

by

Shu-Sha Angie Guan

#### ABSTRACT OF THE DISSERTATION

Social Support across Source and Context:

Implications for Well-Being during Adolescence and Young Adulthood

by

Shu-Sha Angie Guan

Doctor of Philosophy in Psychology

University of California, Los Angeles, 2015

Professor Andrew J. Fuligni, Co-Chair

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Social relationships have great implications for well-being. Positive interpersonal exchanges, such as social support, can be beneficial in buffering the detrimental effects of distress on physiological systems (neuroendocrine, immune, cardiovascular) implicated in the development of chronic diseases. However, characteristics of the support recipient (age, culture), provider (parent vs. peers, Study 1), and context (face-to-face vs. computer-mediated, Study 2) may play a role in shaping the effects of support. The studies in this dissertation examined these factors. Study 1 examined how social support from parents and friends differentially moderated the association between depressive symptoms, hypothalamic-pituitary-adrenal (HPA) axis activity and inflammation among adolescents (N = 316,  $M_{age} = 16.40$ , SD = .74; 57% female) from

diverse backgrounds (23.1% Asian, 29.1% European, 41.8% Latino, and 6.0% other). Results indicated that parent support, but not friend support, moderated the link of depressive symptoms to both total daily cortisol output (a measure of neuroendocrine, HPA activity) and C-reactive protein (a marker of inflammation associated with cardiovascular disease risk). These patterns did not differ by ethnicity. Overall, Study 1 highlights the continued, and perhaps accumulated, importance of parents despite increasing needs for autonomy from and exploration outside of the family unit during adolescence. Study 2 examined how computer-mediated support relative to face-to-face support differentially affects stress reactivity among young adult females (N=103;  $M_{age}$ =19.91, SD=1.91) from Asian (n = 59) compared to non-Asian backgrounds (e.g., African American, European American, Latino, mixed-heritage, n = 44). Participants who received support from a friend through instant messenger before a stressful lab task reported less state anxiety afterward compared to those who did not receive support. Additionally, HPA reactivity across conditions was moderated by ethnicity. Specifically, participants from non-Asian backgrounds who received support face-to-face exhibited less cortisol output throughout the study session compared to their counterparts who received support through instant messenger or not at all. There were no significant differences in cortisol output across all conditions for Asian Americans and no differences were observed for cardiovascular reactivity (heart rate, blood pressure) for all participants. So although new technologies are providing new contexts for social connection, cultural differences in response to in-person support may be reproduced in digital mediums.

The dissertation of Shu-Sha Angie Guan is approved.

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2015

To My Family

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#### **ACKNOWLEDGEMENTS**

This dissertation was made possible by support from the Eunice Kennedy Shriver National Institute of Child Health and Human Development (R01-HD062547), UCLA California Center for Population Research funded by the National Institute of Child Health and Human Development (R24-HD041022), and the UCLA Older Americans Independence Center funded by the National Institute of Aging (P30-AG028748). It was also supported by the UCLA Institute of American Cultures, Asian American Studies Center and the Children's Digital Media Center @ Los Angeles. The views represented here do not necessarily represent the views of the institutions.

I am also eternally grateful to my advisors, who have all unwittingly inspired a line of research in social support. To Andrew Fuligni, whose charm is disarming, cool is calming, patience is genius ...and repertoire of sports idioms knows no bounds. To Patricia Greenfield, for teaching her 'intellectual grandchild' perseverance and strength. To Marjorie Orellana, for her enduring empathy and perspective-taking. To Ted Robles, whose humbleness and balance belies an unbelievable breadth of knowledge. To Kaveri Subrahmanyam, for having been and continuing to be a wonderful role model. To Julie Bower and Teresa Seeman, for joining the large party that is my committee and providing their expertise and invaluable insights.

Many thanks to Tom Bui, Helen Dang, Stephanie Dang, Ashley Hanson, Wan Vivian Ho, Kathy Leung, Spencer Ng, Jessy Nguyen, Wai Yun Suzanne Shing, Anthony Tran, Yuling Tsui, Jacqueline Vu, John Vu, Jessica Westling, Wai Ying Vivien Yiu, and everyone who helped with

data collection on the Multi-Ethnic Study of Social Interaction and Media (MS.SIM). This work would not have been possible (or as fun) without your contributions.

Thanks to my friends, labs and collaborators—my relationships and memories with you all are what I am going to walk away from graduate school treasuring most.

And last but not least, thanks to my parents, brother and extended family for teaching me the rewards of reciprocity and love of learning.

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#### INTRODUCTION

Social belonging is believed to be a biologically-based human need (Baumeister & Leary, 1995), such that social relationships have great implications on our well-being (e.g., Berkman & Syme, 1979; House, Landis, & Umberson, 1988). While the lack or loss of social ties may be linked to poor health (Jaremka et al., 2013; Steptoe, Shankar, Demakakos, & Wardle, 2013), supportive relationships are associated with positive outcomes (e.g., Holt-Lunstad, Smith, & Layton, 2010; Seeman, 1996; Thoits, 1995; Uchino, 2006; Uchino, Cacioppo, & Kiecolt-Glaser, 1996; Wills & Ainette, 2012). They can be especially protective during tough times (Cobb, 1976; Cohen & Wills, 1985; Uchino, 2006).

#### The Mind-Body Connection: Psychosocial Experiences and Physiological Function

Emerging research has begun to examine how social support "gets under the skin" and affect physiological functioning in ways that decrease mental and physical health risk (Eisenberger & Cole, 2012; Holt-Lunstad et al., 2010; Seeman & McEwen, 1996; Thoits, 2011; Uchino, 2006). Psychosocial stressors and distress (e.g., depression, social exclusion, negative evaluation) can alter physiological systems (e.g., neuroendocrine and immune) in ways that can lead to the development of mental and physical disease vulnerability (Eisenberger & Lieberman, 2004; Eisenberger, Taylor, Gable, Hilmert, & Lieberman, 2007; Kiecolt-Glaser, McGuire, Robles, & Glaser, 2002a, 2002b; McEwen & Stellar, 1993; Seeman & McEwen, 1996). Several systems and mechanisms are implicated in the translation of stressful experiences to downstream health-related physiological functioning. Perceived environmental stressors and demands can elicit a response from the hypothalamic-pituitary-adrenal (HPA) axis, often in the release of "stress" hormones like cortisol. These signals can mobilize biological substrates that allow the body to mount an adaptive response (e.g., "fight or flight"; Seeman & McEwen, 1996).

While the body's responsiveness to external stimuli helps maintain internal balance and homeostasis, chronic or inefficient excitation of these systems can lead to dysregulation or "allostatic load" (McEwen & Stellar, 1993). And the potential consequence of high allostatic load can be poorer cognitive and physical functioning and increased risk for disease (Seeman, Singer, Rowe, Horwitz, & McEwen, 1997).

Psychosocial triggers and neuroendocrine responses as those signaled by the HPA axis can also modulate immune function in ways that influence susceptibility to disease (Kiecolt-Glaser et al., 2005; Marshall et al., 1998; Marucha, Kiecolt-Glaser, & Favagehi, 1998; Segerstrom & Miller, 2004). The activation of immune response can lead to the production of immune cells that target pathogens and the release of pro-inflammatory signal proteins (cytokines like IL-1, IL-6, TFN-α or C-reactive protein). Inflammation, the strategy the body mounts to remove infectious agents or repair damaged tissues, is one outcome of these pro-inflammatory proteins. Inflammation can be adaptive in defending against antigens and is often experienced acutely as pain, heat, redness or swelling. However, dysregulation of these processes has been linked to cardiovascular disease, osteoporosis, arthritis, diabetes, cancer, and Alzheimer's diease (Bower et al., 2007; Kiecolt-Glaser et al., 2002b; A. H. Miller, Ancoli-Israel, Bower, Capuron, & Irwin, 2008).

#### **Social Support to Well-Being**

Relationships that convey that one is "cared for, loved, esteemed, and a member of a network of mutual obligations" (Cobb, 1976, p. 300) may provide protective coping mechanisms that reduce the effects of stress on health outcomes (Cohen & Wills, 1985; Seeman, 1996; Thoits, 2011; Uchino, 2006; Uchino et al., 1996; Uchino, Holt-Lunstad, Uno, & Flinders, 2001; Wills & Ainette, 2012). Gore (1978), for example, followed married men for two years after

they lost their jobs (the operationalized stressor) and found that those who felt less support from wives and relatives had significantly higher elevations in serum cholesterol, physical illness symptoms, and internalizing symptoms (e.g., depression, anxiety, low self-esteem) compared to men who reported high support. Other studies have found the same protective effects of support among survivors of cancer, myocardial infractions (i.e., a heart attack), among pregnant women, those with depression, and HIV-infected youth (Berkman, Leo-Summers, & Horwitz, 1992; Lucile Capuron, Alain Ravaud, A. H. Miller, & Robert Dantzer, 2004b; Dunkel-Schetter, Sagrestano, Feldman, & Killingsworth, 1996; Ell, Nishimoto, Mediansky, Mantell, & Hamovitch, 1992; Rotheram-Borus et al., 2001). In a review of 148 studies, Holt-Lunstad et al (2010) found that feeling socially connected and supported was associated with reduced mortality risk at rates comparable to quitting smoking, quitting drinking and independent of other health risk factors such as a sedentary lifestyle and high body mass index (BMI).

### Social Support Across Source and Context During Adolescence and Young Adulthood

Much of these studies, however, have focused on older adults and clinical populations. Less is known about these processes during earlier developmental time points in which physiological systems as well as social networks may be experiencing important shifts and increased risk (Furman & Buhrmester, 1992; Nelson, Leibenluft, McClure, & Pine, 2005). Both adolescence and young adulthood are characterized as developmental periods of physical, social and contextual change. In contemporary American society, these transitions are marked by individuation and increased autonomy from the family coupled with an increased orientation toward peers as individuals leave for college and begin to think about starting careers and families of their own (Arnett, 2000; Erikson, 1968; Furman & Buhrmester, 1992; Nelson et al., 2005). During this period of exploration and instability, all members within the social network

may be important sources of support for youth navigating new expectations and challenges.

Given the social changes occurring during these periods, does support from parents and peers confer the same benefits?

New opportunities for social connection through digital media have also remained relatively unexplored despite the increasing prevalence of computer-mediated interpersonal communication, especially for younger age groups (Lenhart, Purcell, Smith, & Zickuhr, 2010). An important growing body of research suggests that support within new digital spaces, such as across chat sessions, in video-relayed and simulated in a virtual world, can act in similarly protective ways as in-person support by reducing loneliness, depressive symptoms, feelings of nervousness, and physiological stress (Kane, McCall, Collins, & Blascovich, 2012; Shaw & Gant, 2002; Thorsteinsson, James, & Gregg, 1998). This may be especially true for socially anxious individuals who report a preference for computer-mediated interactions given affordances such as increased response-time allowances and control in impression management (Reid & Reid, 2007). Additionally, individuals from cultural contexts that emphasize not burdening others, maintaining self-reliance, and report reduced support-seeking as a result, may exhibit different support response patterns (Kim, Sherman, & Taylor, 2008; Taylor, Welch, Kim, & Sherman, 2007). Given the influence of cultural and digital contexts, do particular individuals benefit from interactions in mediums that increase opportunities for impression management?

#### The Current Dissertation

This dissertation extends the current literature by examining the effect of social support in various forms to physiological profiles in the face of distress. Study 1 compared the role of support from different sources—parents and peers—in moderating the established link between

depression and physiological functioning during adolescence, an understudied period of emergent risk. Study 2 expanded on this approach in establishing the effect of support across different contexts—offline face-to-face and online via instant messenger—in moderating physiological reactivity to an acute lab stressor. These contexts have become increasingly popular for social connection among these age groups. Study 2 also explored cultural differences in response to social support and focuses on research highlighting differences in stress response to support seeking between Asian Americans and European Americans (Taylor et al., 2007).

# Study 1:

Social Support across Source during Adolescence

#### Social Support Across Sources during Adolescence

Major depression is the most common psychiatric disorder afflicting adolescents (Lewinsohn, Hops, Roberts, Seeley, & Andrews, 1993). First depressive onset is most likely to occur during this developmental period (Avenevoli, Knight, Kessler, & Merikangas, 2008) and lifetime rates of depression rise from childhood to comparable adult rates during adolescence (Kessler et al., 1994; Lewinsohn et al., 1993). Adult depression has been associated with poor physical health (e.g., Compare et al., 2013; Frerichs, Aneshensel, Yokopenic, & Clark, 1982). Therefore, this period of emergent depression risk is important to examine given that adolescence often sets the stage for later adult health.

Neuroendocrine and immune dysregulation may be potential pathways through which depression affects physical health outcomes (Murri et al., 2014; Slavich & Irwin, 2014). Although the monoamine theory of depression has been dominant in the last decades, recent studies suggest depression is related to hypothalamic-pituitary-adrenal (HPA) axis activity and inflammation in adults (for a review, see Slavich & Irwin, 2014). Few studies have examined these links in adolescence, a period of physiological and social change.

Additionally, social support, which can often be a protective coping mechanism and has been associated with positive health outcomes, may moderate these relationships (e.g., Uchino, 2009). However, given changes to social networks during adolescence, in increasing orientation toward peers and movement away from the family, social support from different sources may confer different benefits across development (Furman & Buhrmester, 1992; Nelson et al., 2005; Stice, Ragan, & Randall, 2004). The current study examined how social support from parents and friends may differentially moderate the association of depressive symptoms with HPA

activity and C-reactive protein (CRP, a marker of inflammation linked to cardiovascular disease) among adolescents from diverse backgrounds.

#### **Depression During Adolescence**

Neurophysiological changes in social-affective processing during puberty may contribute to the development of affective disorders in adolescence (Byrne, O'Brien-Simpson, Mitchell, & Allen, 2015; Crone & Dahl, 2012; Ge, Conger, & Elder Jr, 2001; Nelson et al., 2005). Teens show heightened emotional responsiveness and physiological reactivity to social stimuli and experiences compared to adults (Monk et al., 2003; Sumter, Bokhorst, Miers, Van Pelt, & Westenberg, 2010). Although negative interpersonal experiences in adolescence have been associated with depressive symptoms (Allen et al., 2006; Ge et al., 2001; La Greca & Harrison, 2005), positive social experiences like social support may be protective (Lewinsohn, Clarke, Seeley, & Rohde, 1994; Stice et al., 2004; Windle, 1992).

#### Depression and the Hypothalamic-Pituitary-Adrenal Axis

Neurobiological pathways may underlie the process through which negative social experiences contribute to depression onset (Kendler, Karkowski, & Prescott, 1999; Müller & Schwarz, 2007; Sapolsky, 2000). Social stressors that activate the HPA axis, often in the release of glucocorticoids, has been associated with the development of depressive symptoms in animal models (Bodnoff et al., 1995). A recent meta-analyses suggests that elevated corticotropin-releasing hormone and basal cortisol levels in the morning, noon and night are hallmarks of major depression among humans adults (Murri et al., 2014). Although HPA dysregulation is often seen among depressed individuals (Maes et al., 1996; Nemeroff et al., 1984), it is also

possible that depressed individuals become more vulnerable to HPA dysregulation over time (Murri et al., 2014).

Among adolescents, pubertal changes may strengthen the association in HPA hyperreactivity and depression (Colich, Kircanski, Foland-Ross, & Gotlib, 2015; Dahl & Gunnar,
2009). Teens who exhibited higher morning cortisol levels, greater rises in morning cortisol
(i.e., cortisol awakening response) and less efficient down-regulation of cortisol across the day
(i.e., flatter diurnal cortisol slopes) tend to be at greater risk for having depression (Adam et al.,
2010; Doane et al., 2013; Owens et al., 2014). Additionally, longitudinal studies suggest that
higher cortisol levels are associated with increased depression onset risk, whereas chronic
depression may blunt cortisol response over time (Booij, Bouma, de Jonge, Ormel, &
Oldehinkel, 2013). The current study examined how social factors may moderate this
established link, especially during a transitional period of biological and social flux.

### **Depression and Inflammation**

Depression is also often coupled with inflammation. Depressed individuals often exhibit higher levels of pro-inflammatory biomarkers like C-reactive protein (CRP) and cytokines (e.g., IFN-α, IL-2) (Elovainio et al., 2009; Elovainio et al., 2006; Irwin & Miller, 2007; G. E. Miller, Stetler, Carney, Freedland, & Banks, 2002; Pike & Irwin, 2006; Raison, Capuron, & Miller, 2006). Patients undergoing immunotherapy and direct administration of pro-inflammatory cytokines in healthy individuals can also often induce these sickness behaviors characteristic of depression (L Capuron et al., 2002; Reichenberg et al., 2001; Strike, Wardle, & Steptoe, 2004; Wright, Strike, Brydon, & Steptoe, 2005; Yirmiya et al., 2000).

Dysregulation of the HPA axis and immune system may be connected, strengthening a risk pathway over time. Although glucocorticoids may have immunosuppressive effects, within certain conditions such as chronic stress, feedback loops between the neuroendocrine and immune systems may become impaired (Irwin & Miller, 2007; A. H. Miller, Haroon, Raison, & Felger, 2013; Pace, Hu, & Miller, 2007; Raison & Miller, 2003; Slavich & Irwin, 2014). That is, chronic immune activation may result in impaired glucocorticoid-mediated inhibition of proinflammatory immune responses. This glucocorticoid resistance is one pathway that can lead to the chronic inflammation and the persistence of sickness symptoms characteristic of depression such as sad mood, fatigue, sleep disturbance, attention/memory impairment and social withdrawal. In addition to affecting HPA activity, growing evidence suggests that hormonal changes during puberty may be associated with increased risk for depression and inflammation, especially among chronically distressed youth (Byrne et al., 2015; G. E. Miller & Cole, 2012; Mitchell & Goldstein, 2014).

#### Social Support as a Buffer

Social support may be a protective coping mechanisms that reduces the effect of negative social experiences on physiological processes and health outcomes (Cohen & Wills, 1985; Seeman, 1996; Thoits, 2011; Uchino, 2006; Uchino et al., 1996; Uchino et al., 2001; Wills & Ainette, 2012). Supportive relationships may affect well-being through changing health behaviors, such as promoting preventative measures and reduced substance use (Cohen & Wills, 1985; Uchino, 2006; Umberson, 1992; Wills & Ainette, 2012). Support can also affect mental and physical health through dampening psychological and physiological reactivity to threatening or challenging events (Cohen & Wills, 1985; Irwin, Daniels, Smith, Bloom, & Weiner, 1987; Seeman & McEwen, 1996; Uchino et al., 1996). Work examining the potential neurocognitive

mechanisms suggest that greater social support may diminish activity in neural regions associated with pain, fear, distress and social separation, that then reduce cortisol and inflammatory reactivity (Eisenberger, 2013; Eisenberger & Cole, 2012; Eisenberger et al., 2007).

Among older adults, high levels of social support may moderate the relationship between inflammation and depression (Lucile Capuron, Alain Ravaud, Andrew H Miller, & Robert Dantzer, 2004a). However, not all studies have found a significant main or moderating effect of social support (McDade, Hawkley, & Cacioppo, 2006; Reblin & Uchino, 2008). Reblin and Uchino (2008) suggest that the lack of consistency may be due to differences in support measures across studies (e.g., in a single context or source, perceived or received). For example, perceptions of available support (perceived support) can be influenced by early family environments and, therefore, is oftentimes stable and related to personality factors (Uchino, 2009). Received support, on the other hand, may be more context-dependent and can co-occur with stressful life circumstances. That is, those who are more stressed may seek out greater support and close social network members may also begin to initiate support provision.

Additionally, the particular characteristics of sample populations (e.g., older adults, clinical samples) may shape the effects of social support in moderating risk pathways. Indeed, adult disease pathways that link depression and physiological processes themselves seem to vary across the lifespan (Andreoli et al., 1993; Bilbo & Schwarz, 2012; Bodnoff et al., 1995; Irwin & Miller, 2007; Murri et al., 2014). The impaired feedback loop in the neuroendocrine, central nervous system and immune systems may begin to emerge and become strengthened during developmental periods such as adolescence, in which physiological systems are calibrating for what may be most adaptive in a particular context (Del Giudice, Ellis, & Shirtcliff, 2011; Low, Matthews, & Hall, 2013; A. H. Miller et al., 2013; Murri et al., 2014; Raison & Miller, 2003).

This may be especially true for those with higher life stress and reduced capacity in coping strategies.

In addition to biological changes, social changes during this period may contribute to depression onset during adolescence. This developmental period is often marked by growing social networks outside of the family unit. Given increased mobility and coupled with desires for autonomy and egalitarianism, adolescents can begin to exhibit a growing reliance on peers and increased conflict with parents (Brown, 1990; Erikson, 1968; Fuligni & Eccles, 1993; Furman & Buhrmester, 1992). The changes are often reflected in reported levels of social support (Furman & Buhrmester, 1992; Scholte, Van Lieshout, & Van Aken, 2001). Yet few studies have compared important support sources during different developmental periods.

#### **The Current Study**

Less is known about how various social resources moderate the links in depression to HPA activity and inflammation during adolescence. To address this gap, the current study examined how social support from parents and friends may differentially moderate the association between depressive symptoms, HPA activity and inflammation among adolescents from diverse backgrounds. Specifically, this study aimed to examine (a) the link between depressive symptoms and daily cortisol output, (b) the link between depressive symptoms and CRP, and (c) the moderation of supportive resources in these relationships.

### Method

#### **Participants**

A total of 316 adolescents ( $M_{age}$ =16.40, SD=.74; 57% female) from Asian (23.1%), European (29.1%), Latin American (41.8%) and other ethnic (6.0%) backgrounds were recruited though concurrent mailings and presentations made in  $10^{th}$  and  $11^{th}$  grade classrooms in four high schools in the Los Angeles area. Adolescents' primary caregiver (89.5 % biological mothers, 2.25 % stepmother/adoptive mother, and 8.25% other) reported their highest level of education from 1= some elementary school to 11= graduated from medical, law, or graduate school and the highest education level of the adolescent's biological father. Parent education was created by taking the mean of the standardized values of mother and father education (M=7.19, SD=1.81). Parents' average level of education was between trade or vocational school and some college. One-way ANOVAs with Bonferroni comparisons indicated that individuals from Asian and Latin American families reported lower parent education levels than those from European and other backgrounds, F(3, 309) = 16.08, p < .001.

#### **Procedures**

All procedures were reviewed and approved by the University of California, Los Angeles Institutional Review Board. In the mailings and during presentations, students were given handouts about the study and recruitment forms that they were to fill out if they were interested in participating. Recruitment forms asked for their name, home telephone number, and e-mail address to assist the research team in contacting the students and parents for consent. For students who returned the form, either after the presentations or at a specified box in the school, project staff contacted homes to explain the study, obtain verbal parental consent, and schedule a visit either at the participants' homes or at a local field research center affiliated with the research team. A few interested families called the research staff directly.

During the initial visit, adolescents provided anthropometric measures and completed a computer-assisted personal interview that included standard psychosocial measures and took approximately 1 hour to complete. Translators fluent in Spanish, Chinese (Mandarin and

Cantonese) and Vietnamese were made available. Upon completion of the survey, finger-prick blood samples for CRP analysis were obtained on the same day. Participants were given athome saliva kits and were instructed to use the Salivette cotton swabs (Sarstedt, Numbrecht, Germany) at five time points across the next three consecutive days: at wake, 15 minutes after wake, 30 minutes after wake, before dinner, and before bed. Participants were instructed to take their morning samples before brushing their teeth, drinking or eating anything. A stamping booklet and electronic time stamper (Dymo Corporation, Stamford, Connecticut) that imprinted the date and time was provided so that participants could record daily saliva collection and aid in compliance. They also reported wake times in daily diaries for each of the three days.

Participants were sent text message reminders on their cellphones before each daily diary entry and cortisol sample. Adolescents were paid \$50.00 for their participation in the study. They were also mailed free movie tickets along with health reports that included information about their blood pressure, body mass index (BMI) and cholesterol.

#### **Measures**

**Depressive symptoms**. Symptoms of depression were assessed through a 20-item scale from the Center for Epidemiologic Studies Depression Scale (CES-D, Radloff, 1977). Participants were asked to report on how frequently (1 = rarely to 4 = most of the time) they felt a certain way (e.g., "I was bothered by things that usually don't bother me," "I felt lonely," "I felt that people disliked me") in the past month. Cronbach's  $\alpha$  was .80.

**Social support**. Adopted from Furman and Buhrmester (1985, 2009), participants reported how frequently in the last 12 months parents and friends provided support (i.e., *How often [your parents/friends] given you advice about your future career plans? How often have [your parents/friends] given you assistance [money, transportation, etc.]? How often have [your parents/friends] given you assistance [money, transportation, etc.]?* 

parents/friends] expressed interest, respect, or care in you? and How often have the [your parents/friends] helped cheer you up when you were feeling down or upset?) on a scale from 1 (almost never) to 5 (almost always). Cronbach's alphas (as) for parent and peer support were .74 and .68, respectively.

**Body Mass Index.** Body mass index (BMI) controlled for abdominal fat, a prime source of inflammation. Interviewers assessed height and weight using a stadiometers and BMI was calculated based on the Center for Disease Control (CDC) height and weight formula where weight in pounds was divided by squared height in inches and multiplied by 703.

CRP. Dried blood spots were obtained the same day as anthropometric and psychosocial survey measures through a minimally-invasive procedure in which the index finger is pricked with a lancet by the participants themselves or by an interviewer. Ten blood drops were allowed to fall onto filter paper without touching the paper. After collection, the samples were covered, dried overnight, and frozen in airtight containers at -80 °C. CRP concentrations were assessed with high-sensitivity enzyme-linked immunosorbent assay (ELISA), which has a lower detection limit of .030 mg/L. All samples were run in duplicate and intra- and inter assay- coefficients of variation were <6.4% and <9.3% respectively. CRP values were log transformed to normalize data. A total of 4 participants had levels of CRP greater than 10 mg/L; they also reported being ill in the last 24 hours and were excluded as this may indicate an acute inflammatory response to an infection. Additionally, although the majority of participants provided blood drops (98.1%), six adolescents did not or could not provide blood samples and are not included in analyses.

**Cortisol.** Approximately 97.5% of participants (n = 308) provided at least one saliva sample, 96.2% (n = 304) provided saliva samples for at least one day, and 86.1% (n = 272) provided all five samples on all three days. Samples were removed from analyses if cortisol

values > 60 nmol/L (n = 2) or if they were paired with noncompliant sampling time recording (e.g., reporting the same sampling time for all five samples within the same day, n = 2). Saliva samples were frozen and stored at -20°C until assay analysis. After thawing, Salivettes were centrifuged at 3,000 rpm for 5 minutes and salivary concentrations of cortisol were measured using a commercially available chemiluminescence-immunoassay with high sensitivity (IBL International, Hamburg, Germany). The intra- and inter- assay coefficients for cortisol were below 8%. Cortisol values were log transformed before analyses to normalize the data. Sampling times from the stamping booklet were converted into military time ( $M_{wake} = 7.80$ ,SD = 1.47;  $M_{15post-wake} = 8.06$ , SD = 1.47;  $M_{30post-wake} = 8.35$ , SD = 1.45;  $M_{dinner} = 19.04$ , SD = 1.42; and  $M_{bedtime} = 22.84$ , SD = 1.26).

Daily cortisol output was assessed by calculating the area under the curve relative to ground with all five log-transformed cortisol values (Pruessner, Kirschbaum, Meinlschmid, & Hellhammer, 2003). Average cortisol awakening response (CAR) that represents the normative rise in cortisol levels upon awakening and average diurnal cortisol slope (DCS) that represents the decline in cortisol levels across the day in healthy individuals was also calculated (Stawski, Cichy, Piazza, & Almeida, 2013). The CAR was calculated by subtracting peak (30 minutes after wake) from wake values and dividing by number of hours separating the two samples. The resulting values are positive to reflect the rising rate of cortisol per hour in the morning. The DCS was calculated by subtracting bedtime from peak values and dividing by the number of hours between samples. The resulting values are negative to reflect the rate of cortisol decline after the morning peak. Participants missing a relevant cortisol value or sampling time were also missing an AUC, CAR or DCS value for that particular day. Averaging these cortisol indices

across the three sampling days increased the likelihood of obtaining at least one estimate of these parameters for each individual.

Average wake times in the 3 sample days may affect cortisol and were controlled for in cortisol analyses. They were also converted to military time (M = 7.60, SD = 1.32 hours). Additionally, dummy-coded variables were created to indicate if a participant was noncompliant in providing samples on any of the 3 sampling days. Specifically, noncompliance was defined as reporting greater than 30 minutes between the wake sample and 15 minute post-wake sample (Flag 1) and greater than 60 minutes between the wake and 30 minute post-wake samples on any of the 3 sampling days (Flag 2). Approximately .014% of samples were coded with Flag 1 and only .012% were coded with a Flag 2. However, we used a conservative control in which individual participants were assigned a code of 1 for each flag if they had a non-compliant sample for any of the three days. Of participants, 6 had both a Flag 1 and 2, 6 had only Flag 1, and 5 had only Flag 2 on one of the days. These noncompliance dummy-codes were included as controls in models with cortisol and removed if they were not significant and did not affect the results.

#### **Results**

Table 1-1 shows that the sample was relatively healthy sample with low depressive symptoms, high average levels of parent and friend support. The majority of participants (80.1%) fell generally in the clinically-recommended low-risk range for CRP (<1mg/L), 12% in the borderline (1-3mg/L), 4.7% moderately high (3.01-10mg/L) and 1.3% markedly high (>10mg/L) risk ranges (Pearson et al., 2003; Ridker & Cook, 2004). One-way ANOVAs with Bonferroni comparisons indicated adolescents from Latin American backgrounds had higher BMI than adolescents from Asian and European backgrounds, F(3, 309) = 6.07, p < .001.

Adolescents from Asian backgrounds reported lower levels of parent support compared to adolescents from European and Latin American backgrounds, F(3, 209) = 4.07, p = .007. Females reported higher levels of depression (M = 1.86, SD = .54 vs. M = 1.69, SD = .50) and friend support (M = 3.72, SD = .72 vs. M = 3.54, SD = .79) compared to males, ts(313, 311) = -2.98, -2.06, ps < .05. They also had higher levels of cortisol AUC (M = 27.16, SD = 7.49) than males (M = 23.87, SD = 7.62), t(283) = -3.63, p < .001.

Bivariate correlations in Table 1-1 indicated that depressive symptoms positively correlated with AUC but was not significantly related to CRP. Parent support and friend support were not associated with CRP but friend support was positively correlated with AUC. To examine the moderating role of support relationships in the relationships between depression, AUC and CRP, a series of hierarchical regressions were modeled. Main continuous variables were standardized into z-scores (where 1 = 1 standard deviation from the mean, 0 = the mean, and -1 = 1 standard deviation below the mean) before they were entered into regression models for interpretation of the intercept and to reduce multicollinearity with interaction terms. In step 1, the sociodemographics, depressive symptoms, parent or peer support, and other controls were entered. In step 2, the interaction between parent or friend support and depressive symptoms was entered.

#### **Predicting Cortisol**

As shown in Table 1-2, females and individuals who reported higher depressive symptoms exhibited higher AUC levels. However, parent support interacted with depressive symptoms to predict AUC. Additional analyses with the noncompliance controls added to the model did not change the results. The noncompliance controls were also not significant and were subsequently removed from the final model. To examine these associations with other

individual differences in cortisol that may be informing AUC, similar regressions were modeled to predict waking level cortisol, bedtime cortisol level, CAR, and DCS. As shown in Table 1-3, parent support did not moderate the association between depressive symptoms to single-sample cortisol levels (i.e., awakening, bedtime) but did significantly moderate the relationship between depressive symptoms and cortisol slope values (i.e., CAR, DCS). As shown in Figure 1-2, the relational patterns were similar to those found for cortisol AUC.

Follow-up regressions in which parent support was mean-split were modeled to examine the simple effect association between depressive symptoms and AUC for those with high parent support and those with low parent support. Additional analyses identifying regions of significance (Preacher, Curran, & Bauer, 2006) also indicated that slopes were non-significant between z = .12 to 14.722. Simple slopes outside of this region were significant. Figure 1-1a shows that, for individuals who reported low levels of parent support, higher levels of depressive symptoms were significantly associated with higher daily total cortisol output. However, this association between depressive symptoms and AUC was not apparent for individuals with high levels of parent support. This interaction was not significant for friend support. Instead, higher friend support was associated with higher AUC levels.

### **Predicting C-Reactive Protein**

As shown in Table 1-4, older adolescents and those with higher BMI exhibited higher CRP levels. As with AUC, parent support but not friend support interacted with depressive symptoms to predict CRP. Follow-up regressions with mean-split parent support were modeled to examine the simple effect association between depressive symptoms and CRP for those with high parent support and those with low parent support. Again, additional analyses identifying regions of significance (Preacher et al., 2006) also indicated that slopes were non-significant

between z = -.88 to 3.99. Simple slopes outside of this region were significant. Figure 1-1b shows that higher levels of depressive symptoms were associated with higher levels of CRP for individuals who reported low levels of parent support. This association was not significant for individuals who reported high levels of parent support.

#### Discussion

The current study examined how sources of support may differentially buffer the link between depression and biological markers of physical health during adolescence. Results indicated that parent support, but not friend support, moderated the link of depressive symptoms to both cortisol AUC and CRP. Specifically, for teens who received low parent support, higher levels of depressive symptoms were associated with greater HPA activity and inflammation. Additional analyses of diurnal cortisol indicate that this buffering was apparent for dynamic indices of daily output (slopes) but not for levels at singular time points. This is consistent with research on diurnal cortisol and depression during adolescence (Adam et al., 2010; Doane et al., 2013). They also highlight particular diurnal elements that may have contributed to observed differences in overall cortisol output (i.e., cortisol AUC) and may reflect dysregulation in various underlying mechanisms. These patterns did not appear for teens who received high parent support. Support from friends did not moderate these links.

The results suggest that social support may be a particularly important coping mechanism to examine during adolescence in addition to other forms of coping (Low et al., 2013). It also highlights the continued, and perhaps accumulated, importance of parents during adolescence. Despite the increasing need for autonomy, it appears that parent-child relationships remain influential during adolescence (Fuligni & Eccles, 1993; Galambos, Barker, & Almeida, 2003; Helsen, Vollebergh, & Meeus, 2000). These findings are in line with prior work showing that

parents and peers may function independent of one another (Furman & Buhrmester, 1985; Helsen et al., 2000) and that positive relationships with parents may be particularly effective in promoting mental well-being during this developmental period (Greenberg, Siegel, & Leitch, 1983; Lewinsohn et al., 1994; Stice et al., 2004; Windle, 1992).

Notably, individuals who reported high parent support may have higher mean levels of cortisol and inflammation. These findings are intriguing considering social support is believed to be related to positive health outcomes. This may be due to the nature of received support measured here, which can be context-dependent compared to perceived support (Uchino, 2009). That is, received support that may not match the receiver's goals (e.g., giving advice rather than providing emotional support to someone who is bereaving) can actually be perceived as negative. Additionally, there can be bidirectional relationships between stress and received support, whereby individuals who are distressed seek out more support as a means of coping with particular stressors (Barrera, 1986; Uchino, 2009).

The cross-sectional nature of this study precludes explanations and conclusions about directionality. However, I turn to longitudinal studies of depressive symptoms and social support from various sources to shed light on the differences found here. There seems to be greater evidence for higher levels of family cohesion and support predicting lower levels of future depressive symptoms (Garrison, Jackson, Marstellar, McKeown & Andy, 1990; Herman-Stahl & Pettersen, 1999; Sheeber, Hops, Alpert, Davis & Andrews, 1997; Stice et al., 2004; Lewinsohn et al., 1994). Depressive symptoms does not seem to predict lower levels of family support. On the other hand, these and other studies often find that friend support is predicted by past depressive symptoms rather than predictive of future depressive symptoms (Coyne, 1976; Young, Berenson, P. Cohen & Garcia, 2005; Stice et al., 2004). That is, depressed individuals

who receive parent support may see a reduction in their symptoms and but may also receive less support from friends. These results also suggest the possibility that those who are depressed may seek out more parental support but may experience more rejection from peers.

This prior literature provides insight in characterizing teenagers who report receiving high levels of parent support in the present study. Specifically, for adolescents high in depressive symptoms, higher parent support may reflect greater stress from depressive symptoms and a greater need to seek out and, subsequently, receive higher levels of parents support. This may explain their exhibiting higher cortisol levels. Similarly, those receiving high parent support in the absence of high levels of depressive symptoms may be experiencing other interpersonal stressors and receiving higher levels of parent support. Teenagers experiencing high levels of depressive symptoms who do not receive the parent support they need may be the least adjusted, as indicated in their cortisol and inflammation levels. In the end, those low in depressive symptoms and who do not need or receive high levels of parent support may be the most adjusted. Longitudinal analyses in the future would help disentangle the relationships found here.

Additionally, in the current study, higher levels of parent support were associated with higher friend support. Higher friend support was, in turn, associated with higher cortisol AUC. If adolescents who report high levels of parent support are also receiving high levels of support from friends, this may be indicative of greater needs for support or create more opportunities for interpersonal conflict (e.g., Rook, 1990). This can be especially true if friends are providing opposing viewpoints relative to parents or if there are greater opportunities for negative experiences in social exchange with peers.

Moreover, although parent and friend support are positively correlated, they may act as separate and compensatory resources. That is, adverse childhood experiences and contentious parent-child relationships at home may lead to higher HPA activity and motivate adolescent reliance on friend support (Anda et al., 2006; Danese et al., 2009; Fuligni & Eccles, 1993; Goldstein, Davis-Kean, & Eccles, 2005; Kalmakis & Chandler, 2015; G. E. Miller & Cole, 2012). Similarly, high parent support may be indicative of challenges in the peer domain as parents are more reliable sources of support whereas friendships are more likely to change over time and include elements of both acceptance and rejection (e.g., Stice et al., 2004).

It should also be noted that the construct of parent support examined in this study may be tapping into other protective factors, such as family cohesion or parenting style, that have been associated with mental health outcomes (Farrell & Barnes, 1993; Galambos et al., 2003; Uchino, 2009). These early experiences may contribute to creating "positive psychosocial profiles" that predispose individuals to perceive more support from others, more effectively use coping strategies, and otherwise alter the mechanisms through which social support affects health (Uchino, 2009). Therefore, future studies would benefit from examining other family and peer factors that may moderate adolescent health risk.

Other limitations with the scales used in the current study should be noted. The depressive symptoms measure in this study was not a diagnostic measure of clinical depression and the results reflect associations among a relatively healthy population of adolescents. Also, I focused on functional measure of social support (e.g., instrumental, emotional support) rather than the structural (e.g., number of friends, frequency of contact) and this may contribute to the heterogeneity of results across the literature (Uchino, Bowen, Carlisle, & Birmingham, 2012; Uchino et al., 1996). Given the strong link between social integration to mortality (Berkman &

Syme, 1979; House et al., 1988; Seeman, 1996), other behavioral mechanisms that link social relationships to health bear examination.

Despite the limitations, this study contributes to the literature in showing that the importance of parent support for diverse groups of adolescents may extend to physical wellbeing as well as mental well-being. It also contributes to greater understanding of how social support may operate in moderating health outcomes during adolescence. This is important given that the extant literature is mixed and often examines these relationships in adults. Although some adult studies have found a direct or buffering effect (Lucile Capuron et al., 2004b; Nakata, Irie, & Takahashi, 2014; Uchino, 2006; Uchino et al., 1996), other studies have found a weak or no relationship (Glei, Goldman, Ryff, Lin, & Weinstein, 2012; Mezuk, Roux, & Seeman, 2010). Consistent with the findings in this study, the source of support seems to matter. Nakata et al (2014), for example, found that higher levels of support from supervisors in the workplace, but not support from family or friends, were associated with lower levels of IL-6, an immune marker of inflammation. In a review of 81 studies on social support and physiological processes, Uchino et al (1996) found that familial sources may be particularly important. However, in many cases, "family member" may include spouse. Given the apparent importance of intimate partners during adulthood (Kiecolt-Glaser & Newton, 2001) and the emerging importance of dating partners during puberty (Furman & Wehner, 1997), future studies should examine the role of support from romantic partners among adolescents.

Additionally, the current study may contribute to our knowledge about the factors that disrupt the coupling of depression and biological mechanisms linked to the development of physical health conditions. It is believed that childhood stressors can induce chronic inflammation in adulthood by promoting the formation of a neuroimmune pipeline, in which pro-

inflammatory signaling pathways between the brain and body are strengthened (G. E. Miller, Chen, & Parker, 2011; G. E. Miller & Cole, 2012). Miller and Cole (2012), for example, found the clustering of depression and inflammation for individuals who had experienced childhood adversity but not in those who had not. Similarly, the current study found that the association between depressive symptoms to hormonal dysregulation and pro-inflammatory profiles emerged only in adolescents who reported low parent support but not for those who reported high parent support.

Altogether, these results support prior research on the role of social support in moderating the effects of stress on well-being. However, the patterns found here suggest that parental factors may be especially important for adolescent health despite social network changes and growing autonomy concerns. These results have clinical implications in suggesting that interventions that improve parent-child and family-child relationships during adolescence can be beneficial.

Table 1-1
Descriptive Data and Correlations for Study 1 Variables

Variable	M	SD	1	2	3	4	5	6	7
1. Parent Education (1-11)	7.19	1.81	-	11†	03	.03	.03	18**	.04
2. Body Mass Index (BMI)	23.16	5.01		-	.02	.00	.01	.47**	03
3. Depressive Symptoms (1-4)	1.79	.53			-	23**	06	.03	.18**
4. Parent Support (1 − 5)	4.32	.70				-	.24**	.03	.02
5. Friend Support (1 – 5)	3.64	.75					-	.02	.12*
6.CRP (log)	-1.30	1.46						-	07
7. Cortisol AUC	25.78	7.70							-

<sup>†</sup>*p* < .10, \* *p* < .05; \*\**p* < .01

Table 1-2 Stepwise Hierarchical Regression Models Predicting Cortisol Area Under the Curve from Depressive Symptoms, Parent Support and Friend Support

	Parent S	Support	Friend S	Support		
	Step 1	Step 2	Step 1	Step 2		
	b (SE)	b (SE)	b (SE)	b (SE)		
Intercept	25.57 (.84)***	25.30 (.84)***	25.47 (.83)***	25.46 (.83)***		
Age	36 (.46)	36 (.46)	41 (.46)	40 (.46)		
Gender	1.60 (.47)**	1.65 (.47)***	1.55 (.46)**	1.64 (.47)***		
Latino	.07 (1.13)	.17 (1.13)	.16 (1.13)	.15 (1.13)		
Asian	.29 (1.31)	.31 (1.30)	.36 (1.28)	.43 (1.28)		
Other	-2.33 (2.08)	-2.41 (2.06)	-2.20 (2.06)	-2.15 (2.06)		
Parent Education	.41 (.48)	.45 (.48)	.38 (.48)	.41 (.48)		
BMI	31 (.46)	25 (.45)	35 (.45)	29 (.46)		
Depressive Symptoms	1.23 (.48)*	1.08 (.48)*	1.22 (.46)*	1.19 (.47)*		
Support	.24 (.47)	.34 (.47)	.92 (.44)*	.87 (.44)*		
Average Wake Time	-1.62 (.47)**	-1.66 (.47)***	-1.64 (.47)**	-1.68 (.47)***		
Depressive Symptoms x Support		97 (.45)*		.43 (.43)		

*Note*. Cortisol values were log-transformed before analyses. Gender was effect-coded such that males were coded -1 and females coded 1. European Americans were coded as the reference group for ethnicity. All other continuous predictors were mean-standardized. Flag 1 indicates participant reported more than 30 minutes between the wake sample and 15 minute post-wake sample on any of the 3 sampling days. Flag 2 indicates participant reported more than 60 minutes between the wake and 30 minute post-wake samples on any of the 3 sampling days.

<sup>\*</sup>p < .05. \*\*p < .01. \*\*\*p < .001

Table 1-3 Stepwise Hierarchical Regression Models Predicting Cortisol Samples and Slopes from Depressive Symptoms, Parent Support and Friend Support

	Waking	Bedtime	CAR	DCS
Step 1				
Parent Support	.03 (.03)	.04 (.04)	03 (.07)	.00 (.00)
Friend Support	01 (.03)	.04 (.04)	.06 (.07)	.00 (.00)
Step 2				
Depressive	.02 (.03)	.02 (.04)	18 (.06)**	.01 (.00)**
Symptoms				
x Parent Support				
Depressive	.00 (.03)	.04 (.04)	.01 (.06)	.01 (.00)
Symptoms				
x Peer Support				

*Note*. Cortisol outcomes are averages and from logged cortisol values. Each support source was modeled separately. Waking = cortisol level at wake sample. Before bed = cortisol level at before bedtime sample. CAR = cortisol awakening response. DCS = diurnal cortisol slope. Sample time was controlled for in waking and before bedtime cortisol levels analyses. Wake time was controlled for in slopes (CAR, DCS). All models controlled for age, gender, ethnicity, parent education and BMI as in analyses with AUC. Supports and depressive symptoms were grand-mean centered.

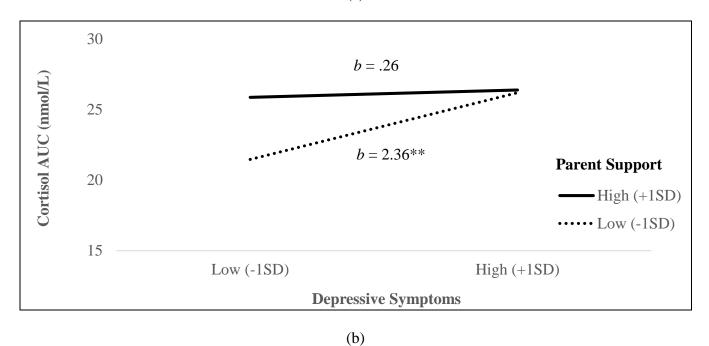
Table 1-4
Stepwise Hierarchical Regression Models Predicting C-Reactive Protein from Depressive Symptoms, Parent Support and Friend Support

	Parent S	Support	Friend Support			
	Step 1	Step 2	Step 1	Step 2		
	b (SE)	b (SE)	b (SE)	b (SE)		
Intercept	-1.17 (.14)***	-1.21 (.15)***	-1.17 (.14)***	-1.17 (.15)***		
Age	.28 (.08)***	.28 (.08)***	.28 (.08)***	.28 (.08)***		
Gender	.07 (.08)	.08 (.08)	.07 (.08)	.07 (.08)		
Latino	12 (.19)	12 (.19)	13 (.19)	13 (.19)		
Asian	39 (.22)	38 (.22)	40 (.22)	40 (.22)		
Other	.00 (.34)	03 (.34)	.00 (.34)	.00 (.34)		
Parent Education	18 (.08)*	18 (.08)*	18 (.08)*	18 (.08)*		
BMI	.62 (.08)***	.64 (.08)***	.62 (.08)***	.62 (.08)***		
Depressive Symptoms	.04 (.08)	.04 (.08)	.03 (.08)	.03 (.08)		
Support	.01 (.08)	.04 (.08)	01 (.08)	.01 (.08)		
Depressive						
Symptoms		16 (.07)*		03 (.07)		
x Support		•				

*Note*. CRP values were log-transformed before analyses. Gender was effect-coded such that males were coded -1 and females coded 1. European Americans were coded as the reference group for ethnicity. All other continuous predictors were mean-standardized.

<sup>\*</sup>*p* < .05. \*\**p* < .01. \*\*\**p* < .001

(a)



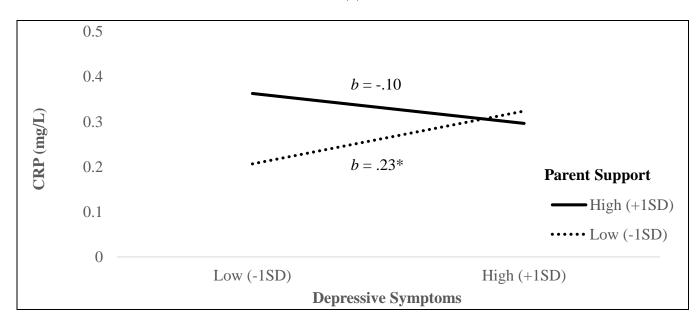
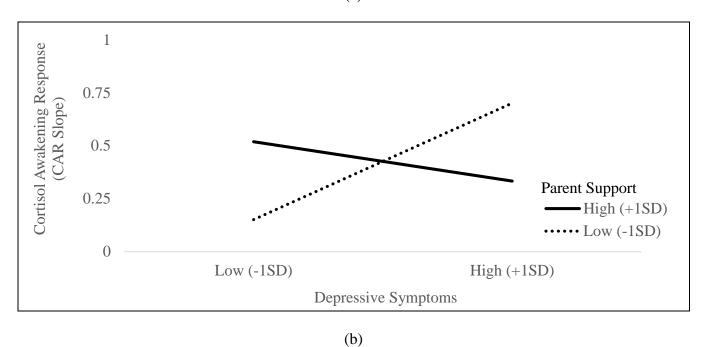


Figure 1-1. The interaction between depressive symptoms and parent support to (a) AUC and (b) CRP.



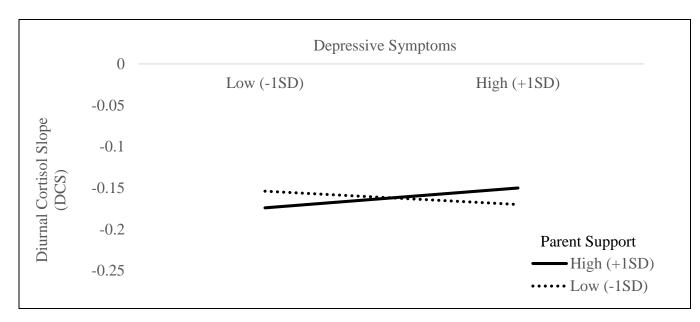


Figure 1-2. The interaction between depressive symptoms and parent support to (a) cortisol awakening response (CAR) and (b) diurnal cortisol slope (DCS).

# Study 2: Social Support across Context during Young Adulthood

## Social Support across Context during Young Adulthood

Although social support has traditionally been conceptualized as a face-to-face interaction, it is now increasingly accessible via "virtual networks" and through the Internet.

New opportunities for social connection through digital media have remained relatively unexplored despite the prevalence of computer-mediated interpersonal communication, especially for younger age groups (Lenhart et al., 2010). Additionally, few studies have examined potential ethnic differences in the benefits gained from social support despite cultural influences in support seeking (e.g., Kim et al., 2008).

# **Computer-Mediated Support**

Teens age 12-17 and young adults 18 -29 are the largest consumers of media (Pew Research Center, 2012). That is, 95% of teens and young adults are online – far outpacing older adults in Internet adoption. Approximately 63% of teens report going online daily (36% multiple times a day and 27% at least once a day). On a daily basis, young people are texting, visiting a social networking site, emailing, and instant messaging—that is, they are connecting socially and gathering cultural information (Common Sense Media, 2012). Their communication partners and source of information are often peers.

Although communication through new media is becoming increasingly accessible, there may be individual differences in rates of adoption and the benefits gained. For example, socially anxious and inhibited individuals generally report preferring text over phone calls (Reid & Reid, 2007). These individuals cite text as a superior method of expressive and intimate contact. This preference may be strongest for individuals who tend to disclose less in-person since text-based, computer-mediated communication can decrease inhibition, reduce opportunities for negative

social evaluation, and increase means for managing self-expression (Reid & Reid, 2007; Shepherd & Edelmann, 2005; Walther & Boyd, 2002).

Recent studies suggest that the digital landscape can be conducive for social support provision (Kane et al., 2012; Shaw & Gant, 2002; Thorsteinsson et al., 1998). But the results on cortisol and cardiovascular reactivity are mixed. Thorsteinsson, James and Gregg (1998), for example, found that video-relayed support attenuated salivary cortisol and heart rate, but not blood pressure, in a demanding computer task compared to a no support condition. Among adolescents, Seltzer, Prososki, Ziegler and Pollack (2012) found that girls who communicated with their mothers face-to-face or over the phone showed lower levels of salivary cortisol after a speech and mental math task compared to girls who communicated through instant messaging or did not receive support. The authors suggest that there may be something comforting in the sound of a familiar voice. However, these studies have not examined ethnic differences in physiological reactivity to support.

## **Cultural Context and Social Support**

Cultural contexts may also shape the effect of computer-mediated social support.

Particularly, Asian Americans, an ethnic group with higher levels of social anxiety and digital media usage (e.g., Hargittai, 2010; Okazaki, 1997), may find computer-mediated communication to be a more neutral conduit of support. Digital, text-based communication can better facilitate impression management and has been shown to decrease feelings of loneliness, stress, depression and negative social evaluation, especially among shyer and less-disclosing individuals (Reid & Reid, 2007; Shaw & Gant, 2002). Additionally, Asian Americans, who often have stronger beliefs in reserve and controlled emotion expressivity, especially in face-to-face interactions

(Leong, 1986; Markus & Kitayama, 1991), may benefit from text-based, digital mediums given the lack of affect visibility.

Although maintaining relational ties is an important cultural value, Asian Americans are less likely seek out close others for support when distressed compared to European American and Latinos (Guan & Fuligni, 2015; Kim et al., 2008; Moilanen & Raffaelli, 2010; Taylor et al., 2004). Interdependent cultural values in self construal may help explain these ethnic differences. For example, the emphasis on interdependent values and sensitivity to others' perceptions (Markus & Kitayama, 1991) may heighten fears of negative social evaluation and loss of face when seeking help for personal problems (Kim et al., 2008; Okazaki, 1997). Taylor, Sherman, Kim et al. (2004) found that Asian and Asian American participants were less likely to solicit support in times of distress due to relational concerns such as disrupting group harmony, burdening others and eliciting criticism. Kim et al. (2008) suggest that this may also be associated with increased reservations about self-disclosure or disclosure of personal problems to close others. Therefore, although explicitly asking for support has been found to dampen cortisol response after a laboratory stressor among European Americans, it induced greater cortisol output for Asian Americans (Taylor et al., 2007). The authors suggest that Asian Americans may be more likely to use and benefit from forms of social support that diminish feelings of anxiety or distress.

## **The Current Study**

Despite the benefits of computer-mediated communication, few studies have examined
Asian American media use in stress-coping. Therefore, the current study examined how
computer-mediated support relative to face-to-face support differentially affects stress reactivity
among young adults from Asian American backgrounds compared to their counterparts from

European American and other ethnic backgrounds. I hypothesized that individuals from non-Asian backgrounds supported in-person would exhibit dampened psychological and physiological stress compared to those supported via a digital, text-based medium and who do not receive support. This is may be due to limitations placed on facial and verbal expressivity in text-based mediums that, in turn, impede intimacy in ways that Seltzer et al. (2012) suggests. I hypothesized that Asian Americans would show a different pattern. Specifically, those supported through the digital medium would show the lowest levels of psychological and physiological stress response followed by those who do not receive support and the greatest levels of stress in after support in-person. This may be due to lowered anxiety and inhibition in the text-based medium.

I also explored how these potential ethnic differences may be mediated by social anxiety and cultural values of interdependent and independence. I expected individuals who report higher levels of social anxiety to report higher levels of interdependence and lower levels of independence. I hypothesized that social anxiety and cultural values would mediate ethnic differences across support contexts. That is, Asian Americans would have higher levels of social anxiety and interdependence, which would in turn be associated with higher levels of stress in response to support in-person compared to in the text-based medium or no support. Lastly, I hypothesized that higher stress response would be associated with higher social anxiety and media use. That is, individuals who showed greater stress in response to support would be higher in social anxiety and would show a greater preference for computer-mediated communication.

## Method

# **Participants**

Undergraduate females (N=103;  $M_{age}=19.91$ , SD=1.91) from Asian (n=59) and non-Asian backgrounds (2 African Americans, 5 European Americans, 21 Latinos, 9 from mixed-heritage backgrounds, and 7 from "other" categories, n=44) were recruited through the Psychology Subject Pool or through flyers around campus. The majority of participants were second generation (58.3%, they were born in the U.S. but at least one parent was foreign born), 33% were first generation (they and their parents were foreign-born), and 7.8% were third generation or higher (they and their parents were born in the U.S.). Of participants from Asian backgrounds, 43.1% were first generation and 56.9% were second generation. Of participants from non-Asian backgrounds, 20.46% were first generation, 61.36% were second generation, and 18.18% were third generation or higher. The non-Asian and Asian American groups in this study were more heterogeneous in ethnic background and generational status than comparisons groups in prior studies (e.g., Taylor et al, 2007) as inclusion was expanded to recruit a greater number of participants.

Female participants were chosen to control for potential gender differences that have been found in previous studies on physiological reactivity (Kudielka & Kirschbaum, 2005). Additionally, given gender role norms that emphasize nurturance and emotional expressiveness in females in comparison to emotional control in males can also affect perceptions of available support and a willingness to seek it out (Barbee et al., 1993). Prior studies have used similar samples (Seltzer et al., 2012; Sherman, Michikyan, & Greenfeld, 2013). Participants completed a survey on sociodemographics and psychosocial behavioral measures as well as completed a lab task. Parent education was assessed on a scale from 1 = no formal education to  $7 = \frac{1}{2}$ 

and 4.87 (SD = 1.80), respectively. This was between technical or trade school and community or junior college.

## Design

There were three experimental conditions into which participants were randomly assigned. In the *face-to-face* (F2F) condition (n = 39), participants would receive support inperson from a female friend. Friend pairs in this condition were in the same room but were not be allowed to touch. In the *instant messaging* (IM) condition (n = 32), participants were instructed to seek support from partners located in a separate room and through an instant messaging program (Google Chat, Google, California). The last condition was a control condition (n = 32), where no support were provided to participants. Table 2-1 shows the ethnic breakdowns by condition.

## **Procedure**

All participants were pre-screened either through phone or email to make sure they (1) could bring in a female friend of the same ethnicity they have known for at least 3 months, (2) were fluent in English, (3) were not pregnant, (4) did not have a cold in the last 24 hours, and (5) did not have any cardiovascular, inflammatory, blood-related, autoimmune, gastrointestinal, periodontal conditions or cancer. They were excluded if they had any of these conditions or were pregnant as these health statuses may affect cortisol, heart rate, and blood pressure levels. For participants who qualified, lab sessions were scheduled 12 p.m. to 6 p.m. to control for the circadian rhythm of cortisol and maximize cortisol reactivity (Ditzen et al., 2008; Ellenbogen, Hodgins, Walker, Couture, & Adam, 2006; Gaab et al., 2003; Taylor et al., 2007). Participants randomly assigned to the F2F or IM conditions were instructed to bring their friend to the lab. All participants were instructed not to eat or drink anything 30 minutes before their appointment.

Figure 2-1 shows the timeline for cortisol, heart rate and blood pressure collection. Upon arrival, participants and friend were led to separate rooms. After providing consent, both participants and their friends individually completed a brief questionnaire about themselves (age, ethnic background, height, weight, parents' background, education and income) and their friendship (length, quality). During this period, a sphygmomanometer cuff (Dinamap Model 1846, Critikon, Florida) was attached to participants' non-dominant upper-arm to assess heart rate and blood pressure routinely every 3 minutes during the entire session while participants continued to write. This consent and questionnaire period acted as a resting period before the collection of the first baseline measures.

Psychosocial stress was induced with the Trier Social Stress Test (TSST) which includes a 5-minute speech task followed by a 5-minute mental math task that has been reliably shown to induce an endocrine response (Kirschbaum, Pirke, & Hellhammer, 1993). Participants were read instructions that asked them to prepare a 5-minute speech on why they would be the appropriate candidate for the position of administrative assistant to the lab (speech task). They had 10 minutes to prepare comments. During this preparation period, partners in the F2F and IM conditions were supported by their friends.

Friends (n = 72) were trained to provide support during participants' resting baseline period. They were instructed to provide at least one statement that represented four types of support identified in the research, emotional, instrumental, informational and validation. As shown in Table 2-3, they were given a script (Robles, 2007) that contained the definition and benefits of each type based on prior research (Nagurney, 2001; Wills & Shinar, 2000). Additionally, they were given examples of each and were encouraged to re-phrase the examples in their own words to best simulate natural interactions. They were also given example questions

they could ask, such as "how are you feeling?" and "how are you organizing your speech?" Friends were instructed to provide at least two questions of each type to participants during the preparation period.

After the 10-minute preparation period, friends were removed and the second cortisol sample was collected from the participant. Two confederates (trained research assistants) were brought into the room with the participant to administer the laboratory challenge (i.e., TSST). After the 5-minute speech task to an audience of the two confederate "judges," participants were asked to count aloud backwards from 2,083 by 13s (mental math task). To increase the evaluative climate, confederates stared and did not smile, nod or make affirmative verbal responses (e.g., "mm-hmm") during the TSST. Instead, they used standardized responses such as "You still have some time left--Please continue" when participants run out of prepared comments and "Stop, please restart at 2,083" when participants made an error on the mental math task (Kirschbaum et al., 1993).

Participants provided their third, post-challenge salivary cortisol sample after completion of the TSST tasks. Two salivary cortisol samples were collected 10 and 20 minutes after the completion of the TSST task and during the recovery period for a total of five samples.

Psychosocial and behavioral measures were administered during the recovery period to assess the subjective impact of the stressor and social support. The entire session lasted a total of 1 hour and 10 minutes. Participants were given either 2 Subject Pool credits or \$20.00 for their participation. Their friends were given 1 subject pool credit or \$10.00 for their participation.

#### Measures

**Body Mass Index.** Participants reported on height in feet and inches and weight in pounds. Body mass index (BMI) was calculated based on the Center for Disease Control (CDC)

height and weight formula where weight in pounds was divided by squared height in inches and multiplied by 703.

**Cultural Values.** Independent and interdependent self-construal were assessed separately a from 24-item scale (Singelis, 1994). For independent value orientation, participants reported how much they endorsed (1 = strongly disagree to 7 strongly agree) items such as "My personal identity independent of others is very important to me," "I prefer to be direct and forthright when dealing with people I've just met" and "I am comfortable with being singled out for praise or rewards." For interdependent value orientation, participants reported how much they endorsed (1 = strongly disagree to 7 strongly agree) items such as "It is important for me to maintain harmony within my group," "I will sacrifice my self-interest for the benefit of the group I am in" and "I respect people who are modest about themselves."

Social Anxiety. The 18-item Social Anxiety Scale for Adolescents (SAS-A, La Greca & Lopez, 1998) captures anxiety on three domains: Fear of Negative Evaluation (FNE, 8 items) assesses concerns or worries about negative evaluation from peers (e.g., "I worry what others say about me"); the Social Avoidance and Distress in New Situations (SAD-New, 6 items) assesses social discomfort in new situations or with unfamiliar peers (e.g., "I get nervous when I meet new people"); and the General Social Avoidance and Distress (SAD-General, 4-items) assesses general social inhibition and distress in the company of peers (e.g., "I feel shy even with peers I know very well"). Participants rate how frequently these statements describe them from a scale 1 *not at all* to 5 *all the time*.

**Media use.** Participants were be asked to report, on an average day, how long they (a) watch video content (TV, YouTube, movies, etc.); (b) play video games;(c) listen to music; (d) read or do homework; (e) e-mail or send messages/post on Facebook, MySpace, etc., (not

including Facebook chat); (f) text or instant message (including Facebook chat); (g) talk on the phone or video chat; and (h) participate in face-to-face conversations on a scale of 0 *never* to 5 *more than 4 hours* (Pea et al., 2012; Rideout, Foehr, & Roberts, 2010).

**State Anxiety.** Psychological stress was measured as state anxiety (short-form STAI; Marteau & Bekker, 1992; Spielberger, 1983) that captures how "calm," "tense," "upset," "relaxed" (reverse-coded), "content" (reverse-coded) and "worried" participants feel in the moment on a scale from 1 *not at all* to 4 *very much*. It was assessed at baseline during the relaxation period and after the TSST challenge during the recovery period.

**Cortisol AUCI.** Area under the curve relative to the increase (AUC<sub>I</sub>) was calculated for each participants (Pruessner et al., 2003). This is calculated by subtracting an individuals' baseline level from the area under the curve of all samples across the entire session. It assesses change in rising cortisol levels over time rather than the total output.

As shown in Figure 2-1, five saliva samples were collected with Salivettes (Sarstedt, Rommelsdorf, Germany) (1) at baseline 20 minutes after participants arrive in the lab, (2) after TSST instruction and the 10 minute speech preparation period, (3) after the 10 minute TSST speech and mental math task, (4) 10 minutes after TSST completion during recovery, and (5) 20 minutes after TSST completion during recovery. Collected samples were stored at -20°Celsius in a commercial freezer until shipped overnight in dry ice to Biochemisches Laboratory, Universitat Trier, Germany to be assayed for cortisol.

All participants provided at least one saliva sample and 97 provided a sufficient amount of saliva on all five samples. The intra-assay coefficient of variation was between 4.0% and 6.7% and the corresponding inter-assay coefficients of variation were between 7.1% - 9.0%. Cortisol values were log transformed before analyses to normalize the data. Outlying cortisol

AUC<sub>I</sub> values were windsorized as the value at two standard deviations above the mean to retain sample size and power.

Cardiovascular Functioning. During the session, heart rate, systolic and diastolic blood pressure were assessed automatically every 3 minutes by a Critikon (Tampa, Florida) sphygmomanometer (Dinamap Model 1846). All heart rate and blood pressure readings before each cortisol sample. On average, there were 4.40 readings per sample: 5.66 readings at baseline before cortisol sample 1, 4.69 readings before sample 2, 4.51 readings before sample 3, 2.72 readings before sample 4, and 3.51 readings before sample 5.

## **Analysis Plan**

To control for individual differences, stress change scores were calculated by subtracting baseline levels from post-challenge levels of cardiovascular physiological stress response. Higher levels indicate greater stress response. Cortisol AUC<sub>I</sub> was assessed to examine HPA axis response to stressor across the study session. Higher values also indicate greater stress response. To examine differences across conditions, by ethnicity, and the interaction between condition and ethnicity, a series of 2 (Asian vs. non-Asian) x 3 (support conditions: F2F, IM, and no support) analysis of variances (ANOVAs) of outcomes were conducted and the interaction term examined. When the interaction term was significant, follow-up planned comparisons were conducted to examine predicted patterns.

To test the degree to which physiological stress response predicted social anxiety and media use for a particular group, regressions that included dummy-codes for the three conditions (with the control condition as reference group), a dummy-code for ethnicity (with non-Asian

participants as the reference group), a centered stress response score, and an stress response by ethnicity interaction term were modeled.

An experimental compliance flag variable was created to account for participants who (1) were not able to provide sufficient saliva, (2) did not bring an ethnicity-matched friend or brought in their sister, (3) had a history of anemia, (4) had completed the TSST in a prior study, (5) reported eating and drinking 30 minutes before the session, (6) were recovering from a cold, and (7) had problems with sphygmomanometer placement. These participants were not removed to retain the sample size and power. However, this flag was included in analyses of physiological outcomes with significant results and removed if it was not significant and did not affect the results.

#### Results

# **Group Equivalence**

To examine the equivalence of participants across the conditions, differences in main study variables at baseline were examined across conditions. As noted in Table 2-1, participants across the three conditions did not differ in parent education level, BMI, interdependence, independence, social anxiety, media use, state anxiety or any of the physiological outcomes at baseline.

Next, independent t-tests were used to examine ethnic differences in the main study variables at baseline. Table 2-2 shows that Asian American participants had lower BMI and higher interdependent value orientations compared to non-Asian participants. The average level of interdependence found in this study was slightly higher than values found for Asian Americans college students in the original construction of the scales (M = 4.91, SD = .76;

Singelis, 1994). Contrary to the results found in prior studies, there were no significant differences in independence and social anxiety. Overall, Asian American young adults in this study had comparable social anxiety scores compared to Asian American young adults in prior studies using the same measure (used sum of same 18-item SAS-A scale, M = 46.02, SD = 14.41 for Asian Americans vs. M = 42.31, SD = 14.75 for Caucasian Americans; Lau, Fung, Wang, & Kang, 2009) and slightly higher than studies with ethnically-diverse adolescent samples (used sum of the same scale, M = 30.09 - 38.26, SD = 11.9 - 12.0; La Greca & Harrison, 2005; La Greca & Lopez, 1998). Lastly, Asian participants had lower baseline heart rates compared to non-Asian participants. The groups were otherwise equivalent in systolic blood pressure, diastolic blood pressure and baseline cortisol.

To examine the moderation of condition by ethnicity on baseline measures of physiological outcomes, a series of between-subjects ANOVAs were conducted. No significant interaction was found for cardiovascular measures (i.e., heart rate, systolic and diastolic blood pressure), Fs(2, 96-97) = .11 - .67, ps = .52 - .90. There was a significant interaction for baseline cortisol, F(2, 95) = 3.48, p = .035. Follow-up pairwise Bonferroni comparisons indicated that Asian participants in the F2F condition exhibited higher baseline cortisol (M = 5.43, SE = .56) compared to non-Asian participants (M = 3.22, SE = .79), F(1, 95) = 5.25, p = .024. This interaction remained significant after controlling for the experimental compliance flag and parent education. However, this interaction became marginal after included BMI, F(2, 93) = 2.60, p = .079. Figure 2-2 presents ethnic differences in baseline cortisol by condition.

Given the hypothesized condition by ethnicity interaction for psychological and physiological stress response, I examined the number of participants in each condition by ethnic group. Table 2-1 shows the sample sizes across the conditions by ethnicity. Although the  $\chi^2$ 

suggests that there are no significant differences between the expected and observed frequencies in ethnic breakdown by condition, the sample sizes in the cells are small and imbalanced.

Therefore, the following results should be interpreted with caution.

## **Psychological Responses**

To check that the TSST had the desired effect, changes in state anxiety were examined. State anxiety after the TSST (M = 2.50, SD = .69) was higher than at baseline (M = 1.73, SD = .55), t(102) = -10.94, p < .001. Examination of state anxiety after the support manipulation and TSST indicated that there was a main effect of condition. ANOVAs with Bonferroni comparisons indicated that participants in the IM condition reported lower levels of post-TSST state anxiety compared to participants in the control condition. There were no significant differences between these conditions and the F2F condition, ps = .343 and .876 respectively. There was no main effect of ethnicity for post-TSST state anxiety, t(101) = 1.59, p = .12. Additionally, there was no condition by ethnicity interaction, F(2, 97) = 1.88, p = .16.

To validate that participants indeed felt supported in the F2F and IM conditions, ratings of friend support were examined. In the post-task survey, participants reported the degree to which (1) they felt support by the presence of their friend during the support manipulation, (2) the presence of their friend in the preparation room had a relaxing influence on them, and (3) the advice given to them by their friend was helpful to them on a scale from 1 = completely disagree to 6 = completely agree. On average, participants agreed that they felt supported by their friend (M = 4.80, SD = 1.08). Participants in the F2F condition (M = 4.74, SD = 1.13) did not report significant differences in feelings of friend support compared to participants in the IM condition (M = 4.97, SD = .98), t(74) = -.91, p = .368. Similarly, Asian participants (M = 4.89, SD = 1.04)

did not report significant differences in reported feelings of friend support after the TSST compared to non-Asian participants (M = 4.64, SD = 1.14), t(76) = -.97, p = .338.

## **Physiological Response**

To check that the TSST had the desired effect on physiological outcomes, paired t-tests were conducted comparing baseline and post-task cardiovascular outcomes and cortisol levels. Results indicated that physiological measures increased from baseline to after the task, ts(99 - 102) = -2.41 to -22.81, ps < .05. Friend support was not associated with change in any physiological measures, rs = -.01 - .13, ps = .39 - .91.

Next, to test physiological outcomes across the conditions and by ethnicity, a series of between-subjects ANOVAs examining differences in changes in cardiovascular indices and cortisol AUC<sub>I</sub> were conducted. In terms of cardiovascular measures, results indicated there were no main effects of condition, Fs(2, 94) = .20 - 1.13, ps > .05, or ethnicity for change in heart rate or systolic blood pressure, Fs(1, 94) = 2.10, .01, ps > .05. However, there was a main effect of ethnicity on diastolic blood pressure such that Asian participants showed greater increases (M = 13.33, SE = .73) compared to non-Asian participants (M = 10.94, SE = .84), Fs(1, 94) = 4.65, p = 034. Lastly, there were no significant condition by ethnicity interactions in cardiovascular response change, Fs(2, 94), = .04 - 2.35, ps > .05.

In terms of cortisol AUC<sub>I</sub>, there were no main effects of condition or ethnicity, F(1-2, 91) = .92, .82, ps = .40, 37 respectively. The interaction was also not significant, F(2, 92) = .51, p = 61. Figure 2-3 shows the logged cortisol levels across the study session by condition and ethnicity.

## **Associations of Stress Response to Individual Factors**

Bivariate and partial correlations were used to explore the associations between stress response and individual factors (i.e., social anxiety, cultural values and media use). I first examined the association between psychological stress, social anxiety, interdependent cultural value orientation and media use. Table 2-4 shows the bivariate correlations between main study variables. Greater change in state anxiety was associated with higher social anxiety as well as higher media use. Contrary to expectations, cultural values of interdependence and independence were not associated with state anxiety changes or media use.

Secondly, I tested the degree to which physiological stress response predicted social anxiety and media use for a particular group. Changes in cardiovascular outcomes did not predict social anxiety (bs = -.04 - .05, SEs = .07, ps = .45 - .58) or media use (bs = -.04 - .04, SEs = .06, ps = .47 - .65) and there were no significant interactions by ethnicity (bs = -.15 - .03, SEs = .12 - .15, ps = .25 - .96). Higher cortisol AUC<sub>I</sub> predicted greater media use (b = .13, SE = .06, p = .034) but not social anxiety (b = .07, SE = .07, p = .33). There were only marginal interactions by ethnicity predicting media use and social anxiety, (bs = -.23, -.26, SEs = .12, .14, ps = .058, .068, respectively).

## **Discussion**

The current study examined the effect of new contexts for social connection. The affordances of new media make it a potentially beneficial context through which to receive social support for individuals who may feel more anxious about seeking it out in-person. Although I found that participants supported via IM reported less post-task state anxiety than those who did not receive support, there were no differences in those supported via IM compared to F2F. Contrary to hypotheses, there was no effect of support condition on psychological or physiological responses among non-Asian individuals. Specifically, I did not see lower levels of

stress in non-Asian females who were supported in the F2F condition compared to IM or control conditions. Additionally, I also did not see the hypothesized pattern in Asian participants.

Namely, psychological and physiological stress response was not lower in the IM or control conditions compared to F2F condition for Asian individuals. In terms of other ethnic differences, individuals from Asian backgrounds had lower heart rate at baseline and greater changes in diastolic blood pressure compared to individuals from non-Asian backgrounds. They also had higher baseline cortisol in the F2F condition compared to individuals from non-Asian backgrounds in the F2F condition.

The present study also examined the association between stress response and individual factors like social anxiety and media use. Greater change in psychological stress and levels of cortisol AUC<sub>I</sub> were associated with higher frequency of media use. However, cardiovascular changes did not predict media use. This partially suggests that more anxious and reactive individuals may prefer computer-mediated interactions. Consistent with prior work with anxious and shy individuals (Reid & Reid, 2007; Shaw & Gant, 2002), it seems that individuals who exhibit greater psychological and physiological response to the social and evaluative stress task tend to partake in more technology-mediated activities like emailing, instant messaging, and using a social networking site.

The discrepancy in self-reported psychological stress as compared to physiological stress may reflect social desirability in perceiving friends as effective support providers and thus reporting lower post-task anxiety. This phenomenon has been documented in prior research with the TSST (Kirschbaum et al., 1995). There may also be a delay in physiological states compared to psychological states (Schlotz, Kumsta, Layes, Entringer & Jones, 2008). That is, psychological states may precede HPA response in a manner not captured here. In the current

study, salivary cortisol was measured only up to 20 minutes after the stress task. Although this reduced the total study time for participants, it also limited analyses of a lagged response or recovery period in that individual variations after those 20 minutes were not documented in the current measure of cortisol AUC<sub>I</sub>. Cortisol can take longer to peak and decline after an acute stressor (Kirschbaum et al., 1993) and failed shut-down of the system may be particularly detrimental to the health (Dickerson & Kemeny, 2004). It is possible that differences in social support might appear during the recovery phase as inefficient down-regulation rather than in the initial rise. On average, participants did not return to baseline levels of cortisol upon the last sample and, therefore, a full recovery was not captured here. In the end, it might be that the affordances of the digital context, in increased response time and reduced visibility of affect displays, may not be enough to minimize physiological stress response to receiving help from a peer. That is, even when social interactions take place within an asynchronous context, the perceived threat to self-esteem of needing help or the extra effort needed to attend to a friend while preparing for a stressful task may still eliminate the positive effects of social bonding and positive affect.

The patterns of stress response by ethnicity found here are inconsistent with previous research (Taylor et al., 2007). Specifically, I did not find ethnic differences in the effect of support for Asian and non-Asian participants in cardiovascular response or cortisol AUC<sub>I</sub>. Instead, I found that Asian participants had higher baseline cortisol levels than non-Asian participants in the F2F condition. This initial difference in baseline cortisol disappeared after accounting for ethnic differences in BMI, suggesting individual differences may have accounted for initial cortisol levels. Non-Asian participants had higher levels of BMI compared to Asian participants and adiposity may be associated with HPA function (Putignano et al 2001; Rask et

al., 2001). Additionally, differences in sample size could have contributed to this difference as I observed the greatest imbalance in sample size in the F2F condition. Because I used simple rather than stratified random assignment, there were more Asian than non-Asian participants in the F2F condition. Subsequently, standard errors in for the Asian group in this condition tended to be smaller, potentially producing ethnic differences in the F2F condition but not in the others.

Key limitations in sample size and population that distinguish it relative to the Taylor et al. (2007) may also have accounted for the non-significant condition by ethnicity interaction. Specifically, imbalanced sample sizes in each condition and the heterogeneity of the comparison groups may have reduced the ability of the current experiment to detect differences across condition and by ethnicity. To increase sample size and subsequent power, recruitment was expanded to include healthy individuals from all ethnic and generational backgrounds. However, this resulted in highly heterogeneous comparisons groups (i.e., Asian American vs. non-Asian American participants). Firstly, the majority of the non-Asian group consisted of participants from non-European American backgrounds. In fact, they were primarily Latino, an ethnic group that may also endorse high levels of interdependence (Fuligni, Tseng & Lam, 1999; Manago, 2014). Although we found higher levels of interdependence among Asian participants, both Asian Americans and Latinos may endorse higher levels of interdependence compared to European Americans. This may explain the lack of ethnic differences in social anxiety relative to prior studies comparing Asian Americans and European Americans (Okazaki, 1997; Lau et al., 2009). Secondly, there were differences in generational status among Asian and non-Asian participants, such that the non-Asian group was primarily second generation whereas the Asian group was evenly split between first and second generation. Although cultural values are often transmitted from generation to generation, there may be variation in endorsement of parental

values from one generation to the next (Manago, 2014; Suzuki & Greenfield, 2002). Education level can also vary by generational status, especially for immigrant populations in the United States whose children are more upwardly mobile (Gans, 2007; Kalmijn, 2006; Mouw & Xie, 1999). Participants in this study were also highly educated, which could mean greater socialization within independent contexts like institutions of higher education. All of these factors (ethnic background, generational status, and education level) may have contributed to greater similarity between the Asian and non-Asian participants in the current study.

Other characteristics of the sample and confederates should be considered. This was an all-female sample and research has documented gender differences in acute stress response (Kirschbaum et al., 1995; Robles, 2007). Robles (2007), for example, found that females exhibited lower levels of cortisol AUC<sub>I</sub> compared to males and females in the support condition did not differ in stress response compared to those in the no support condition. Despite the fact that this prior study used confederates rather than familiar friends in the support condition, the results are in line with the results found here. Additionally, although most of the participants and friend pairs were matched by ethnicity, the confederates in the current study were majority Asian American and not matched by ethnicity to participants. Characteristics of the audience in amplifying the social evaluation and social comparison elements of the TSST are key to eliciting a strong stress response (Dickerson & Kemeny, 2004). Participants across the groups in this study may have perceived the confederates differently. Specifically, non-Asian participants likely performed their speech in front of a cross-ethnic audience but were supported by a sameethnicity friend in the F2F and IM conditions. In comparison, Asian participants saw Asian American faces whether they were in the F2F, IM or control condition. Overall, this could have

restrained or eliminated ethnic differences, reducing stress responses in Asian participants across all conditions and amplifying stress in non-Asian participants.

It is also possible that social support in any of the forms manipulated in this study were ineffective in moderating physiological stress responses. The results found here are inconsistent with prior research indicating that peer support can reduce diastolic, systolic blood pressure and, to a lesser extent, heart rate during challenging lab tasks (for a review, see Thorsteinsson & James, 1999; Uchino et al., 1996). Additionally, these results are inconsistent with prior research that have examined social support to HPA activity within a similar stress paradigm (Seltzer et al., 2012; Taylor et al., 2007). Arriving at the lab with a friend has been shown to reduce cardiovascular activity compared to showing up alone (e.g., Kamarck, Manuck, & Jennings, 1990). However, in these prior studies, friends often provided support during the stressor as well as before. Still, this creates a potential confound as friend pairs assigned to the F2F and IM conditions may have been interacting as they waited before the session. In the work by Taylor and colleagues (2007) examining ethnic differences in HPA activity to a lab stressor, individuals participated in the study alone and were only instructed to think about the people close to them. This issue highlights the difficulty in isolating the timing of effective support provision. Future research should test for other mechanisms that might explain the link between social support and physiological response.

Prior research suggests that implicitly thinking about one's social network may be a more effective alternative to reducing HPA reactivity for Asian Americans (Taylor et al., 2007). In line with this finding, Cheng et al (2011) found that the size of the friends network was a better indicator of well-being than social exchanges with friends among Asian Americans. This is reflective of growing research on invisible received support, which suggest that support an

individual receives but is not conscious of may be most effective in reducing negative psychological states associated with asking for assistance (e.g., negative self-efficacy appraisals, sense of indebtedness; Bolger & Amarel, 2007; Bolger, Zuckerman, & Kessler, 2000; Uchino, Carlisle, Birmingham, & Vaughn, 2011).

Additionally, the current study focused on friend support to reduce the number of conditions and conserve power. However, given the importance of various support providers (Uchino et al., 2011), support providers outside of peers might be more effective in reducing stress states. Support from kin has been found to be influential to HPA activity and well-being (Seltzer et al., 2012). Family members may be especially important for minority groups (Burton, Bonanno, & Hatzenbuehler, 2014) and in interdependent cultures that prioritize family relationships (Fuligni et al., 1999; Kagitcibasi, 2005; Li & Cheng, 2015). Although romantic partners also grow in important during young adulthood, partner support may be more effective for males than females (Kirschbaum, Klauer, Filipp, & Hellhammer, 1995). Future research should examine how support from other sources outside of same-sex friend may affect stress response to acute stressors.

Despite limitations, the current study contributes to our understanding of how new and increasingly popular forms of social connection online may shape mental well-being, though perhaps their effects on physical outcomes are less clear. It also addresses how young adults from diverse cultural backgrounds may respond to received social support across different contexts.

Table 2-1 Sample Size by Ethnicity and Differences in Study Variables Across Conditions

Sample Size by Linnic	tty enter 2 typer erret	Condition		
	Control	F2F	IM	-
Ethnic Group	n	n	n	
Asian	14	26	19	
Non-Asian	18	13	13	
Total	32	39	32	$\chi^2(2) = 3.86$ , ns
	Control	F2F	IM	
Study Variables	M(SD)	M(SD)	M(SD)	
Parent Education	.14 (.89)	.13 (.90)	07 (.94)	F(2,100) = .55, ns
BMI	22.43 (2.04)	22.22 (4.11)	21.57 (3.50)	F(2,99) = .55, ns
Interdependent	4.86 (.86)	5.09 (.67)	4.99 (.64)	F(2,100) = .91, ns
Value				
Independent	4.70 (.67)	4.71 (.77)	4.90 (.98)	F(2,100) = .65, ns
Value				
Social Anxiety	2.42 (.55)	2.56 (.72)	2.31 (.70)	F(2,99) = .1.30, ns
Media Use	2.11 (.62)	2.04 (.63)	1.94 (.49)	F(2,100) = .69, ns
Pre-task (Baseline)	()	. =		<b>-</b> (400)
State Anxiety	1.77 (.60)	1.76 (.51)	1.67 (.55)	F(2,100) = .30, ns
Cortisol	5.02 (3.44)	4.69 (3.00)	4.52 (2.07)	F(2,100) = .24, ns
Heart Rate	76.49 (10.67)	75.07 (9.84)	74.03 (12.01)	F(2,100) = .42, ns
Systolic Blood	104.37 (8.64)	100.95 (7.01)	100.17 (7.81)	F(2,100) = 2.66, ns
Pressure				
Diastolic Blood	66.35 (6.18)	64.38 (5.80)	62.86 (6.24)	F(2,100) = 2.67, ns
Pressure				
D ( 1 (D 1)				
Post-task (Peak)	2.70 ( (0)	2.52 ( (4)	2.27 (72)	F(2 100) 2.25
State Anxiety	2.70 (.68)	2.53 (.64)	2.27 (.72)	F(2,100) = 3.25, p =
				.043
C .: 1	(10 (674)	5.00 (6.2 <b>5</b> )	5 40 (2.06)	Control > IM
Cortisol	6.13 (6.74)	5.98 (6.37)	5.42 (3.96)	F(2,100) = .13, ns
Heart Rate	88.67 (13.87)	85.75 (12.35)	82.41 (13.47)	F(2,100) = 1.73, ns
Systolic Blood	121.03 (15.40)	120.86 (10.89)	119.90 (13.82)	F(2,100) = .07, ns
Pressure	70 12 (0 20)	77 45 (6.92)	75.04 (6.67)	E(2.100) = 1.50
Diastolic Blood	78.13 (8.29)	77.45 (6.83)	75.04 (6.67)	F(2,100) = 1.59, ns
Pressure				

Table 2-2
Differences in Study Variables Across Ethnic Groups

	Ethnic		
-	Asian	Non-Asian	
Study Variables	M (SD)	M (SD)	
Parent Education	.21 (.88)	12 (.92)	t(101) = -1.83, ns
BMI	21.24 (2.91)	23.21 (3.64)	t(100) = 3.04, p = .003
Interdependent	5.11 (.69)	4.82 (.74)	t(101) = -2.03, p = .045
Value			
Independent	4.66 (.77)	4.92 (.86)	t(101) = 1.62, ns
Value	, ,	, ,	
Social Anxiety	2.46 (.61)	2.42 (.75)	t(100) =27, ns
Media Use	2.03 (.61)	2.03 (.55)	t(101) = .01, ns
	, ,	, ,	
Pre-task (Baseline)			
State Anxiety	1.67 (.60)	1.82 (.46)	t(101) = 1.34, ns
Cortisol	4.98 (2.69)	4.42 (3.15)	t(99) =96, ns
Heart Rate	73.31 (10.30)	77.71 (10.93)	t(101) = 2.09, p = .039
Systolic Blood	100.76 (7.45)	103.12 (8.41)	t(100) = 1.50, ns
Pressure			
Diastolic Blood	64.08 (5.49)	65.10 (6.98)	t(100) = .83, ns
Pressure	` ,	, ,	,
Post-task (Peak)			
State Anxiety	2.41 (.66)	2.63 (.72)	t(101) = 1.59, ns
Cortisol	6.08 (5.69)	5.56 (6.10)	t(99) =45, ns
Heart Rate	84.45 (13.85)	87.01 (12.41)	t(98) = .95, ns
Systolic Blood	119.93 (11.08)	121.56 (15.73)	t(99) = .61, ns
Pressure	3 (==3)		. ()
Diastolic Blood	77.54 (7.08)	75.98 (7.57)	t(99) = -1.06, ns
Pressure	· · · - · /	- ()	, , , , , , ,

Table 2-3
Friends' Supportive Behaviors Script

	Supportive Stateme	ents			
Definitions	Benefits	Specific Examples			
Allowing discussion of feelings, expression of concerns or worries	Alters threat appraisals, enhances self- esteem, reduces anxiety/depression, motivates coping	"Remember, it will all be over in a few minutes"  "It's okay to feel anxious about this"  "I definitely understand what you're going through"  "You'll do fine."  "I know you'll be able to get through this"			
Providing tangible assistance	Solves practical problems, allows increased time for coping efforts	"You should structure your speech into 3 parts: Your background, what you bring to this position, and what you like about the position."			
Providing information about resources, advice about effective actions	Increases amount of useable information available to individual, leads to more effective coping	"I've found that writing a brief outline of your main points is helpful" "One thing you can do is come up with 3 items for each main idea of your speech." "It helps to speak at a slightly slower pace, because that makes you look comfortable"			
Providing information on normativeness of individual's behavior and/or feelings, relative status in population	Decreases perceived deviancy, allows acceptance of feelings, provides favorable comparisons	Other participants who have gone through this also feel pretty nervous, so what you're feeling is quite normal"  "It's okay if you stumble a little bit in there; everybody gets nervous when giving a speech in front of people they don't know."			
Sup	portive questions and	responses			
Questions		Responses			
"Do you feel nervo "How are you orga speech?" "What did you wri	ous?" anizing your	"You sound worried" "I understand" "That sounds like a good way to do "Good idea!"			
	Allowing discussion of feelings, expression of concerns or worries  Providing tangible assistance  Providing information about resources, advice about effective actions  Providing information on normativeness of individual's behavior and/or feelings, relative status in population  Sup Questions  "How are you feel "Do you feel nerve "How are you orgas speech?"	Allowing discussion of feelings, enhances self-expression of concerns or worries anxiety/depression, motivates coping  Providing tangible assistance increased time for coping efforts  Providing information about resources, advice about effective actions individual, leads to more effective coping  Providing information of useable individual, leads to more effective coping  Providing information available to individual, leads to more effective coping  Providing individual's acceptance of behavior and/or feelings, relative status in population  Supportive questions and Questions  "How are you feeling?" "Do you feel nervous?" "How are you organizing your speech?" "What did you write down in your			

*Note*. Script is from prior work (Robles, 2007). Functions, definition and benefits was taken from Wills and Shinar (2000) and examples are from Nagurney (2001).

Table 2-4
Descriptive Data and Correlations for Study 2 Variables

	Variable	M	SD	1	2	3	4	5	6	7	8	9	10	11
	1. Parent Education	.00	.94	-	25*	.04	.04	11	24*	06	20†	10	15	15
	2. Body Mass Index (BMI)	22.09	3.37		-	.03	01	.29**	.07	.20*	.10	.04	.00	07
	3. Interdependent Value (1 – 7)	4.99	.72			-	.00	.18†	.06	.04	.15	.10	.01	.09
	4. Independent Value (1 − 7)	4.77	.81				-	19†	05	17†	.15	07	.06	.02
	5. Social Anxiety (1 – 5)	2.44	.67					-	.33**	.33**	.10	.10	.06	.02
58	6. Media Use (1 – 5)	2.03	.58						-	.02	.21*	.09	.03	06
	7. State Anxiety Change	.77	.71							-	.18†	.22*	.06	02
	8. Cortisol AUC <sub>I</sub>	3.42	13.56								-	.22*	.45**	03
	9. Heart Rate Change	9.93	9.47									-	.47**	.27**
	10. Systolic Blood Pressure Change	18.66	9.94										-	.31**
	11. Diastolic Blood Pressure Change	12.33	5.40											-

*Note.* Parent education is the mean of standardized (z-score) mother and father education.

 $<sup>\</sup>dagger p < .10, *p < .05; **p < .01$ 

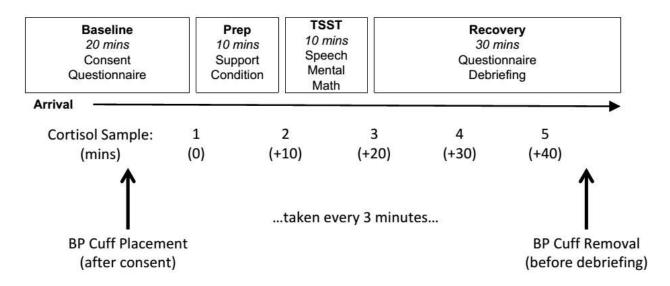


Figure 2-1. Timeline for cortisol, heart rate, and blood pressure collection.

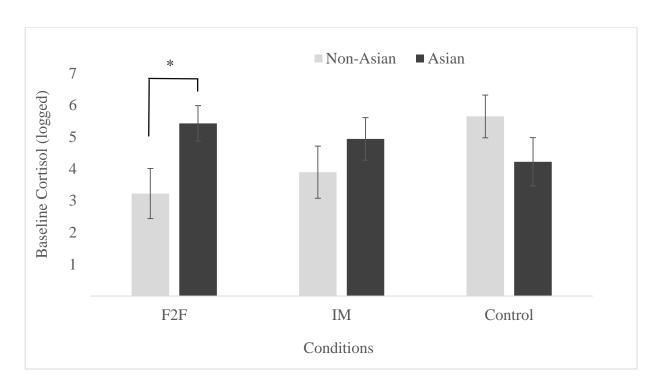


Figure 2-2. Baseline cortisol levels as a function of ethnicity and experimental conditions.

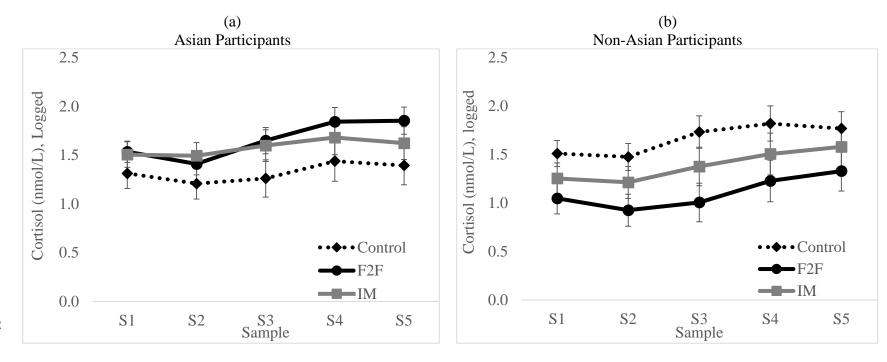


Figure 2-3. Cortisol sample levels across the session for (a) Asian and (b) non-Asian participants by condition.

## **CONCLUSION**

Taken together, these studies add to the literature in assessing the unexplored relationship between distress, support, and physiological markers of health risk at different developmental time points characterized by change and vulnerability. Additionally, the studies contribute to our knowledge of the types of relationships and modes of connection that may matter most or are consistent across cultural and social contexts during these periods. The findings reveal that both support provider characteristics and context/culture matter in shaping support-recipient responses (Kim et al., 2008; Uchino, 2009; Uchino et al., 2012; Uchino et al., 2011). These factors may, therefore, moderate the beneficial effects of support for well-being.

Study 1 suggests that parent support, rather than friend support, modifies the link between depressive symptoms and markers of physiological stress response among adolescents. Although the link between the depressive symptoms and biological markers of health have been established in adult populations, researchers are beginning to examine these links during adolescence, a period of important biological and social change. The study highlights how parental factors may be especially important for adolescent health despite growing autonomy concerns during this period. Adolescents whose families navigate the balance between the need for autonomy and continued family support may fare best.

Study 2 suggests that online communication may confer some benefits in reducing negative psychological states in response to stress. However, it may not ameliorate physiological stress reactivity for individuals from either independent or interdependent cultural backgrounds. Instead, stress physiology may predict general media use preferences. This suggests that digital forms of connection may be beneficial for individuals who are psychologically reactive as well as physiologically reactive. Additionally, the inclusion of the

support provision within the digital context for ethnically-diverse individuals contributes uniquely to the field of social support and culture.

Both studies also suggest that received support in particular contexts can be less than beneficial. Yet, the potential for supportive relationships to create health and happiness is well-documented and there is a growing interest in establishing social guidelines and environments that promote health and prevent disease (Koh, Piotrowski, Kumanyika, & Fielding, 2011). Therefore, future studies should continue to examine individual and contextual factors that predict well-being, taking into account early family factors as well as stressor types. Additionally, as highlighted in the studies here, these individual and environmental factors can interact. As social contexts rapidly change in a modern world that is becoming more digital and global, research should account for social connection across media platforms and culture, especially during periods of amplified social calibration and contextual sensitivity (Del Giudice et al., 2011).

In addition to contributions to a more multi-faceted understanding of how social support across sources and contexts may affect adolescents and young adults, the results across both studies have important clinical implications in identifying types of relationships that may be most influential in moderating biological indicators of health. Broadly, these dissertation studies have identified risk and protective factors in the biological and psychosocial pathways during adolescence and young adulthood that may set the stage for later adult disease risk.

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