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## Does Text Messaged Social Support Attenuate Cardiovascular and Psychological Reactivity to a Laboratory Stressor?

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**Does Text Messaged Social Support Attenuate Cardiovascular and Psychological Reactivity  
to a Laboratory Stressor?**

By

Tabitha C. S. Caley

Accepted in Partial Completion  
of the Requirements for the Degree  
Master of Science

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## Master's Thesis

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Tabitha C. S. Caley

July 30<sup>th</sup>, 2020

**Does Text Messaged Social Support Attenuate Cardiovascular and Psychological Reactivity  
to a Laboratory Stressor?**

A Thesis  
Presented to  
The Faculty of  
Western Washington University

In Partial Fulfillment  
Of the Requirements for the Degree  
Master of Science

by  
Tabitha C. S. Caley  
July 2020

### **Abstract**

The current research examined the effects of text-messaged and in-person social support on cardiovascular and psychological stress responses. Of particular interest to this thesis was the question of whether text-messaged social support offered benefits similar to that of in-person social support. Female undergraduates ( $N = 49$ ) and their female friends participated in an anticipated speech task. The participant's friends provided either in-person ( $n = 14$ ), text-messaged ( $n = 17$ ) social support, or no social support ( $n = 18$ ). Cardiovascular and psychological outcomes were tested by incorporating a series of theoretically driven planned contrasts using HLM piecewise growth curve modeling. In-person social support did not moderate systolic blood pressure (SBP) reactivity but did increase SBP recovery. In-person social support reduced social evaluative threat (SET) during both reactivity and recovery. Text-messaged social support attenuated SBP responses during reactivity, but increased SBP during recovery, and also reduced SET during recovery. This study indicates that text-messaged social support can reduce cardiovascular reactivity to a stressor.

Key words: social support, anticipatory stress task, social evaluative threat, challenge appraisals, emotions, blood pressure, text-messages, instant-messages, computer-mediated communication

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## **Introduction**

Social support can attenuate physiological and emotional reactions that occur as part of the common experience of stress in daily life (Cohen, 2004). Stress occurs when an individual appraises an event as a threat to the psychological or physiological self (McEwen, 2000). The body responds to stress with a physiological stress response, which involves specific patterns of biological activation, including increases in heart rate and blood pressure. These biological functions are adaptive and protective in the short term but can be damaging in the long term (McEwen, 2000). Because repeated or chronic stress can have serious health implications, including increasing the risk of cardiovascular disease (Black & Garbutt, 2002) and lower immune functioning (Kiecolt-Glaser, 2009), it is important to understand the mechanisms by which socially supportive interactions can attenuate the effects of stress on health.

It is possible to reduce the negative health effects of stress through social support (Holt-Lunstad & Uchino, 2015), which occurs when social relations promote health and well-being (Cohen, et al., 2000), or provide psychological or material resources that help an individual to cope with stress (Cohen, 2004). More social support predicts better health outcomes, while poor or nonexistent social support is linked to earlier mortality and poor immune functioning (Uchino, 2006). Social support may come from a variety of sources, including a romantic partner, friends, or family and may include distinct transactions in which a person receives benefits from someone else, or occur when a person feels they have access to help or support from someone (Taylor, 2007).

While there is good evidence for the positive effects of social support when effective social transactions take place in-person (Kirsch & Lehman, 2014), experimental research has not

fully examined contemporary approaches that may be used to provide social support. A survey study asking participants about their use of and feelings about contemporary approaches of communication, such as text messaging and internet messaging, have found that many participants prefer these methods of communication because they give additional time for the recipient to think about how to reply and can help to foster a feeling of emotional distance when discussing emotionally sensitive topics (Harley et al., 2007). Although some research does consider the role of social support provided on the internet, such research has rarely considered physiological effects of that social support (Holt-Lunstad & Uchino, 2015). The current study examined whether it is possible to receive effective social support through text messaging and if so, whether text messaged social support helps to prevent emotional and cardiovascular reactivity to an academic stressor.

It is important to research the beneficial aspects of text messaged social support because most people have cellular phones, which are often a primary mode of communicating with friends and family (Holt-Lunstad & Uchino, 2015). In fact, text messaging is now the preferred form of communication for people aged 18 to 49 years (Forgays et al., 2014). The potential value of text messaged social support rests on its ability to decrease emotional and physiological stress responses.

### **Stress Response**

Stress needs to be understood from both a biological and a psychological perspective. The biological perspective will be discussed first. The physiological stress response involves neurobiological systems that enable the body to keep itself in balance through change, a process known as allostasis (Gunnar & Quevedo, 2006). Stress activates two distinct but interrelated

systems: the sympathetic-adrenomedullary (SAM) system and the hypothalamic-pituitary-adrenocortical (HPA) system. The SAM is responsible for releasing epinephrine, from the medulla, which is responsible for the fight or flight response (Cannon, 1929), while the HPA operates primarily through the production of glucocorticoids (e.g. cortisol). Because this thesis did not measure cortisol response this review will not elaborate on the HPA system; for a review see Gunnar and Quevedo (2006).

Although short term activation of both the SAM and HPA systems are important for adaptive functioning, frequent and/or prolonged activation of these systems lead to deleterious effects on mental and physical health, a concept known as allostatic load or overload (McEwen, 2000). While allostasis is protective, frequent activation of stress response systems can dysregulate the physiological systems. This dysregulation inhibits the ability to turn off the stress response, and physiological systems may stay elevated, potentially fostering chronically raised blood pressure and heart rate (Gunnar & Quevedo, 2007). Allostatic load increases the risk of both physical and mental health problems (McEwen & Seeman, 1999). For example, chronic activation of the physiological stress response can result in a thickening of the arterial walls, an important indicator for heart disease (McEwen, 2006). Epinephrine, and to a lesser extent norepinephrine, is released into the bloodstream when a threat is encountered. Both epinephrine and norepinephrine can increase heart rate and stroke volume, thereby increasing cardiac output of blood. Vasodilation in muscles and constriction of blood vessels within the skin and gut also increases, thus ensuring adequate blood flow to the brain and muscles (Gunnar & Quevedo, 2006).

A primary measure of SAM comes from indicators of cardiovascular responding, including heart rate, systolic blood pressure, and diastolic blood pressure (Frisch et al., 2015). Cardiovascular responding can be reliably induced through tasks that are known to be very stressful for participants, such as public speaking and mental math tasks. Systolic blood pressure (SPB) is a measure of arterial pressure during a heartbeat and diastolic blood pressure (DBP) is a measure of arterial pressure between heartbeats. Cardiovascular reactivity is defined by the magnitude of blood pressure and heart rate increases experienced during a stressor (Hilmert et al., 2002). Exaggerated cardiovascular responding is a risk factor for cardiovascular disease, with greater cardiovascular reactivity leading to a greater chance of developing cardiovascular disease (O'Donovan & Hughes, 2008). Repeated cardiovascular reactivity episodes that are large in magnitude, or include delayed recovery time, contribute to the development of cardiovascular disease (Hilmert et al., 2002). According to the World Health Organization (2017) cardiovascular disease accounts for 17.7 million world wide deaths each year.

A meta-analysis of 175 articles measuring stress responsivity and cardiovascular risk factor found that greater stress reactivity and slower recovery predicted future cardiovascular disease (Chida & Steptoe, 2010). One study showed that requiring participants to give a presentation increased cardiovascular responding (HR, SBP, & DBP), cortisol, and negative psychological responses (e.g. anxiety & depression; Al'Abisi, 1997). Additionally, greater cortisol reactivity was correlated with greater cardiovascular responding during the speech tasks. Al'Abisi hypothesized that cortisol may also play a role in the development of cardiovascular disease since greater cortisol was correlated with increased HR, SPB, and DPB. A literature review investigating the multivariate relationship between depression, social support (marital and

social), and cardiac disease outcomes found that low social support and depression are independent risk factors for cardiovascular disease (Compare et al., 2013). Additionally, the absence of social support predicted adverse outcome for people suffering from cardiovascular disease. Enhancing social support may be one way to reduce the magnitude and frequency of cardiovascular reactivity episodes (Uchino et al., 1996).

The extent to which a potentially stressful event increases cardiovascular reactivity depends on how the event is psychologically appraised. When a personally relevant stressor is encountered it is appraised somewhere on a continuum between threat and challenge (Seery, 2013). The biopsychosocial model of threat and challenge suggests that appraisals occur during situations that a person perceives to be personally important. For example, a presentation would likely be seen as important by a college student (Blascovich et al., 1999). When the task (e.g. a presentation) is seen as important, people automatically evaluate whether they have the resources to meet the task demand (Seery, 2013). This resource appraisal involves checking ones skills, abilities, and energy level. If the person decides they have the resources to meet the demand then a challenge appraisal is more likely to be made. Challenge appraisals activate the SAM axis, which increases cardiac output by dilating the arteries and increasing heart rate. However, if that person believes they do not have the resources required to meet a particular demand, a threat appraisal is more likely to be made. More threat appraisal predicts both SAM and HPA axis activation which constricts the arteries and decreases overall cardiac output in spite of increased heart rate. Heart rate is increased for both threat and challenge appraisals. Resources are automatically reevaluated and updated as the stressful situation changes; therefore it is possible for a challenge appraisal to change to threat if situational demands surpass resources.

Furthermore, upward social comparison negatively affects resource appraisals by creating the feeling that one does not have the resources to meet the demands. Upward social comparison happens when a person compares themselves to someone they believe is performing better than they are, which may elicit feelings of social evaluative threat (Taylor & Lobel, 1989). In reality, this appraisal process should be understood as a continuum, with psychological and physiological responses falling somewhere between a threat and a challenge (Seery, 2013).

### **How Stress is Studied**

Laboratory studies of stress frequently employ some form of public speaking to activate the appraisal process and evoke a stress response. Public speaking elicits strong physiological stress responses regardless of whether it is measured using cardiovascular reactivity or cortisol levels (Kirschbaum et al., 1993). A common laboratory stress task is the Trier Social Stress Test (TSST). The TSST consists of verbal mental arithmetic (e.g. being asked to count backwards out loud by 13 from 1456) and public speaking performed in front of an evaluative audience. This evaluative audience is typically comprised of research assistants who have been trained to keep their faces neutral of expression and not give any encouragement whatsoever thereby inducing social evaluative threat in the participant (Holt-Lunstad & Uchino, 2015; Uchino et al., 1996). Social evaluative threat occurs as a result of a threat to one's sense of self (Dickerson et al., 2008). Participants who underwent the TSST also reported high levels of stress and anxiety (Frisch et al., 2015), and most likely experienced a threat appraisal. Another common laboratory stress task is the anticipated speech task, which consists of a speech preparation phase followed by a practice phase, usually in front of a video camera (Bolger & Ameal, 2007). The reason it is called an anticipated speech task is because after participants complete the practice phase they

are told that they do not need to actually give the more formal presentation. When experiencing a stressor during a laboratory study, cardiovascular reactivity is expected to be low before the stressor (i.e. baseline) but then increase as they experience the stressor, or are told about the stressor in the case of anticipated speech tasks. Once a stressful event is over, cardiovascular reactivity returns to baseline over a period of time, this period is called recovery (Frisch et al., 2015; Kirsch & Lehman, 2014). A fast recovery is typically indicative of good cardiovascular health, while a slow recovery is indicative of poor cardiovascular health (Steptoe & Marmot, 2005).

Stress can also be studied in a naturalistic environment, such as the home. For example, Allen et al., (1991) asked female participants to participate in a mental arithmetic stressor while measuring SBP, DBP, and HR both in the lab and then later at their home. Lehman and Conley (2010) had undergraduate participants wear an ambulatory blood pressure monitor for four days and found increased blood pressure during times participants reported increased momentary social evaluative threat. Another study was able to replicate Lehman and Conley's findings using an adult workforce sample (Bowen et al., 2014). These strategies are useful because ambulatory blood pressure reactivity better predicts cardiovascular disease than laboratory reactivity (Pickering et al., 2006).

### **Social Evaluative Threat**

Because of the importance of naturally occurring blood pressure changes for health, both blood pressure and social evaluative threat should be examined in a naturalistic setting. As explained by the social self preservation theory, threats to one's social image or social standing can elicit social evaluative threat and produce emotional and biological changes (Bosch et al.,

2009; Dickerson & Kemeny, 2004; Dickerson et al., 2008; Frisch, Hausser, & Mojzisch, 2015), including increases in negative emotions, pro-inflammatory cytokines, blood pressure, and cortisol (Dickerson et al., 2004). Threats to the social self involve threats to self-esteem, status, and social acceptance (Frisch et al., 2015). Situations that hold the possibility for negative evaluations about important and critical aspects of oneself from others, such as job interviews or oral presentations, have the greatest ability to elicit social evaluative threat (Frisch et al., 2015; Dickerson et al., 2008; Gruenewald et al., 2004). Much like the effects of stress on the physiological systems, chronic or repeated exposure to threats to the social self can lead to negative health outcomes, such as depression and lower immune functioning (Dickerson et al., 2009).

In a laboratory study, Bosch et al. (2009) found that participants who gave a speech to an audience comprised of one person reported greater increases in anxiety, shame, negative affect, HR, SBP, and DBP compared to participants in the no-audience condition. The same study showed that participants who gave a speech to an audience comprised of four people had greater HR and blood pressure than participants who gave a speech to an audience of one. Participants can also experience social evaluative threat from support providers if providers are in the room during the stressor task or when participants are informed that support providers will listen to them from another room (O'Donovan & Hughes, 2008; Thorsteinsson & James, 1999). However, Dickerson et al. (2008) found that the mere presence of another does not increase feelings of social evaluative threat. Instead the participant must feel actively observed, which suggests that social evaluative threat could impede the provision of social support if the support provider is with the person during a stressor.



## **Effects of Stress on Emotion**

Depending on the strength of response to a stressful situation, many distinct emotions may be experienced (Feldman Barrett et al., 2007). Emotions may be experienced together or separately from each other. Diener et al. (1995) tested different categories of emotions based on past research and agreed that there are six basic emotion categories: love, joy, fear, anger, shame, and sadness. Furthermore, each of those six emotion categories can be represented by four emotion words that were found to load highly on their respective category through a factor analysis.

However, basic emotions do not fully explain self-conscious emotions, such as shame, guilt, and pride, that are sometimes experienced during stressful situations (Tracy & Robins, 2004). A key difference between basic emotions and self-conscious emotions is that the latter requires self-awareness, self-representation (i.e. a sense of self), and a situation that makes one evaluate the self (e.g. presentation, athletic event, performance). The desire to avoid (or experience) self-conscious emotions tend to be omnipresent in our desire to maintain our sense of self (Baumeister et al., 1994). Situations likely to produce social evaluative threat, such as giving a classroom presentation, will likely elicit self-conscious emotions because both rely on self-awareness and a sense of self. Thus, the experience of both social evaluative threat (Lam et al., 2009) and self-conscious emotions (Tracy & Robins, 2004) may be especially likely to affect physiological functioning. For example, Lehman et al. (2015) found that greater momentary social evaluative threat was associated with greater anxiety, worry, shame, embarrassment, and anger. Additionally, participants who reported greater social evaluative threat still reported feelings of anxiety, worry, and embarrassment and had elevated systolic blood pressure and heart

rate one hour later, suggesting that the psychological effects of experiencing social evaluative threat may be relatively long lasting. However, socially supportive relationships can help decrease the physiological and psychological effects of stress (Holt-Lunstad & Uchino, 2015; Uchino, 2006).

### **Social Support**

Social support occurs when social relations promote health and well-being (Cohen et al., 2000), or provide psychological or material resources that help an individual cope with stress (Cohen, 2004). Social support is a multidimensional concept that encompasses both structural and functional components. Structural aspects of social support refer to how well an individual is situated within their social networks, including the number of friends, marital status, and participation in social activities (Uchino, 2006). Functional aspects of social support refer to specific functions that provide for the individual relationships (Ditzen & Heinrichs, 2014; Holt-Lunstad & Uchino, 2015).

Social support may come from a variety of sources, including family, pets, coworkers, or a therapist (Allen et al., 2002). Social support may occur through distinct transactions during which a person receives benefits from someone else, or may simply be present when a person feels they have access to help or supportive social relationships (Taylor, 2007). Further, social support is sometimes categorized as being emotional or problem focused. Emotional support includes the provision of empathy, concern, and love that makes the recipient feel that they are valued and cared for. Informational support is the offering of advice, guidance, suggestions, and other things that help the recipient better cope with a stressor (Holt-Lunstad & Uchino, 2015).

The current study included both emotional support and informational support, though differences

in effectiveness of emotional support and informational support were not a central focus of this research.

According to the buffering hypothesis, social support can reduce stress reactivity both by limiting stress exposure and by providing resources that reduce the duration of the stressor (Holt-Lunstad & Uchino, 2015). There is good evidence that people with larger social networks and those who perceive support is available to them show less reactivity to stress (Ganzel et al., 2010; Holt-Lunstad & Uchino, 2015; Uchino, 2006). Those who believe that social support is available also tend to have stronger emotion regulation and coping skills, and therefore greater social support predicts a less extreme psychological and physiological stress response (Cohen & Wills, 1985). An ambulatory blood pressure study of married heterosexual couples found that perceived informational social support buffered momentary stress outside of the laboratory (Bowen et al., 2014).

In spite of benefits of social support, many studies show that provision of social support can result in either null effects or heightened stress reactivity (Ganzel et al., 2010; Holt-Lunstad & Uchino, 2015; Uchino, 2006; Uchino, 2009). Social support may be ineffective in part because of the possibility for social evaluative threat. This concern may be especially likely in low quality relationships between support provider and recipient. The majority of past social support research assumed that all relationships are positive, ignoring the possibility that a relationship may not have the qualities needed to provide effective social support (Holt-Lunstad & Uchino, 2015). However, relationship quality may help to explain some surprising social support results (Bagwell et al., 2005; Uno et al., 2002).

Both gender dynamics and relationship quality appear important for understanding social support transactions. Uno et al. (2002) found that female participants considered close female friends to be more supportive than close male friends. Uno et al. asked participants to give three speeches. While participants prepared each speech, their friend wrote them a supportive note. The content of these notes was randomly assigned to provide emotional social support, instrumental social support, or an apology for not being able to think of anything to say. Receiving social support from a friend one considers ambivalent was associated with more emotional negativity than when participants received social support from a non-ambivalent friend (Uno et al., 2002). Ambivalence is experienced when a person is unsure if the friend truly supports them. Additionally, cardiovascular reactivity was greater when participants received social support from an ambivalent female friend than from non-ambivalent female friend.

Overall, when the possibility of social evaluative threat and relationship quality are considered, social support can attenuate the psychobiological stress response (Bolger & Aermal, 2007; Holt-Lunstad & Uchino, 2015; Kirsch & Lehman, 2014). Nearly all studies of social support provision looked only at in-person transmission of social support. However, because of the increased presence of different forms of communication, such as the internet and cellular phones, it is necessary to examine the efficacy of social support through other forms of communication.

### **Computer-Mediated Communication**

Since the early 1970's researchers have examined the social psychological effects of communicating using computers (Kiesler et al., 1984). Originally this line of research was limited to people who used computers for their job (Kiesler et al., 1984). However, the field of

computer-mediated communication has grown to encompass any investigations of technology, including Facebook (Nabi et al., 2013), other social networking sites (Pollet et al., 2010), and text/instant-messaging (Rains et al., 2016). These investigations are important because according to the PEW Research Center (2018) 88% of 18-29 year olds use some form of social media (i.e social networking sites) and 94% own a smartphone.

Since the majority of young adults own smartphones and use social media, it is important to evaluate how social support operates in a digital text-based environment. Within the computer-mediated communication literature there is a lack of consensus on the psychological effects of Facebook use. For example, an experience-sampling study that asked participants to report their Facebook use and subjective well-being five times a day for two weeks found that Facebook use predicted less momentary well-being and life satisfaction (Kross et al., 2013). In contrast, Frison and Eggermont (2015) found that participants who sought social support on Facebook and then reported receiving social support, reported lower levels of depression following the receipt of social support. Additionally, greater reported online social support predicted less depression and less social ostracism (Cole et al., 2017). Manago et al. (2012) report that when more of a person's Facebook friend list is comprised of people with whom they maintain an active friendship, the individual is more likely to view Facebook as a tool for soliciting social support. In addition, an online survey investigating possible redundancies between online and in-person social support habits found that for students with low levels of in-person SS there was little overlap between in-person social support from friends and online social support (Cole et al., 2017). However, students with strong in-person social support had a lot of redundancy because their in-person and online social support network were comprised of the same support providers.

The authors hypothesized that this discrepancy between participants high and low in in-person social support could occur because those lacking the necessary social skills to find in-person friends instead search online for people who are able to provide social support.

Although most technologically-mediated communication research has examined social support received or provided through online instant messaged social support, some literature does focus on text messaging. Two laboratory studies have used text messaging as a mode of social support provision. Holtzman et al. (2017) found that participants who received in-person social support reported more positive affect than those receiving text messaged social support or no social support. However, participants in the text messaging condition reported more positive affect than those who did not receive social support.

Another study addressed the effects of text messaged social support on physiological stress responses (Seltzer et al., 2012). In this study, adolescents completed a child version of the Trier Social Stress Test and their mothers provided social support in-person, over the phone, through instant message, or not at all. Social support provided in-person and over the phone predicted lower cortisol reactivity than the instant message and no support groups. In this study, adolescents who received support through instant messages fared no better than adolescents who received no social support. However, it is possible that the reason instant messaged social support did not attenuate the stress response is because parents did not actually provide social support in their messages. Instead, the authors indicated that some mothers asked practical questions like “What do you want for dinner?”. Therefore, it is not possible to conclude that text messaged social support does not offer the same physiological benefits as in-person social support. However, a recent study shows that college students report using text messages to

provide and receive social support (Caley et al., 2018). In combination, these results suggest that further research is needed.

### **Study Hypotheses**

The current research examined the effects of text messaged and in-person social support on physiological and psychological stress responses. Specifically this study tested the following hypotheses:

Hypothesis 1: Participants who receive social support, whether it is in-person or texted, will have lower cardiovascular and psychological reactivity and faster recovery to a stressor than participants who do not receive social support.

Hypothesis 2: Participants who receive text-messaged social support will have lower cardiovascular and psychological reactivity and faster recovery to a stressor than participants who do not receive social support.

Hypothesis 3: Participants who receive in-person social support will have lower cardiovascular and psychological reactivity and faster recovery to a stressor than participants who do not receive social support.

This thesis did not make a direct comparison between in-person social support and text-messaged social support as we did not expect text-messaged social support to be more effective at attenuating cardiovascular and psychological reactivity and recovery than in-person social support.

## Method

### Participants

This sample consisted of 49 female participants and their 49 female friends who were recruited students enrolled in lower division psychology classes. Participants signed up for a study on digital distraction and were asked to bring a good female friend to a psychology laboratory. In exchange for their participation, participants received two research credits and a \$10 Amazon gift card, while friends received a \$15 Amazon gift card. The total sample was 66.7% Caucasian, 5.2% Latino/Hispanic, and 19.8% identified as multi-ethnic; 2% did not identify their ethnicity. Participants were randomly assigned to one of three conditions: in-person social support ( $n = 14$ ), text-messaged social support ( $n = 17$ ), and control ( $n = 18$ ).

### Procedure

#### *Participant Procedure.*

Prior to arriving at a psychology laboratory, participant-friend dyads were randomly assigned to one of three conditions: text messaged social support, in-person social support, or no social support. Participants were asked to report with their participating friend to a psychology laboratory where they were told this is a study on the impact of social interactions while studying. Participants and their friend were taken to separate rooms and then asked to complete informed consent and friendship quality. After completing the friendship quality measure participants had an ambulatory blood pressure cuff put on their non-dominant arm for the remainder of the session with a baseline reading taken approximately 10 minutes after their arrival to the laboratory. Blood pressure (BP) readings were collected automatically every 10 minutes after the first measure. Participants also completed measures of social evaluative threat,



discrete emotions, and a brief threat/challenge appraisal measure at multiple times during this study. As shown in Figure 1, participants completed the first set of measures 10 minutes after arriving at the lab and then completed this set of measures after each block of the session.

Questions were shown on a computer set up in the room.

After waiting for 10 minutes, a researcher explained the cover story to the participant. Specifically the cover story explained that past research shows that although supportive contact from friends can be useful, digital and in-person interactions while preparing for an important presentation can reduce the ability to stay focused and can potentially negatively impact grades. For precise wording see Appendix A. Participants were then told that they had to give a 15 minute presentation on a topic that is important to them and that this would be in front of a panel of graduate students who are judging them on how well they are able to construct an interesting and informative presentation. They were told that they would be given 15 minutes to prepare and 15 minutes to practice the speech. A researcher then instructed the participant that they had 15 minutes to prepare the speech. The researcher then left the room, however during the first five minutes, the friend either text-messaged supportive messages, came into the room to offer social support in-person, or did nothing. Once the five minutes were over, the friend was instructed to stop texting or was removed from the presence of the friend. A researcher then instructed the participant to complete the self report measures and that they had 10 minutes remaining to prepare for the speech. Once the 10 minutes were over, a researcher entered the room and told the participant that it was time to practice their speech in front of the camera. Once the practice phase was over, a researcher told the participant that they did not actually need to present their speech, but that they did need to fill out some more surveys and wait for 30 minutes in order to

capture the full cardiovascular stress response. Once the 30 minutes were over participants were debriefed, informed that the gift card would be emailed to them, and then thanked for their time.

### ***Friend Procedure.***

During the initial session, friends were separated from the participant after they completed the informed consent. Friends were then told that they needed to provide social support to the participant during the first five minutes of the speech preparation phase. Friends who were comfortable with providing social support were shown a list of social support phrases and they were told to choose at least five phrases to be used to provide social support either in person or through text messaging. The social support phrase book (shown in Appendix B) is a set of phrases that offer either emotional or informational social support. An example of emotional support is “You are awesome and I believe in you.” An example of informational support is “Create small note cards with the main points and then practice in a mirror.”

The social support phrasebook helped to ensure that what friends were saying or text messaging are in fact phrases that would be considered messages of social support. This phrasebook was developed from an online study that asked female students for actual instrumental and emotional social support phrases that they have sent to friends during times of academic stress (Caley, Struthers, Stafford, & Lehman, 2018). Friends were allowed to slightly modify each phrase (e.g., u instead of you) to better fit the typical verbal or text messaging style.

### ***Measures and Materials***

**Cardiovascular responses.** Systolic blood pressure, diastolic blood pressure, and heart rate were measured using the Ambulo 2400 oscillometric ABP monitors every 10 minutes for a total of 9 readings. The Ambulo has been validated according to British Hypertension Society

guidelines (Alpert, 2010). SBP, DBP, and HR were analyzed separately. There were considerable problems with the blood pressure equipment leading to HR missing 19.4% of responses, SBP missing 18.6% of responses, and DBP missing 16.7% of responses. See Table 4 for descriptive statistics.

**Friendship quality.** A 22 item measure adapted by Chen, Kim, Sherman, & Hashimoto (2015) from two separate relationship quality measures. The first is an 11 item measure adapted from Gere and MacDonald (2013) that measures friendship trust, intimacy, and satisfaction. The second is an 11 item measure adapted from the Couple's Relationship Satisfaction Index (CSI; Funk & Rogge, 2007). Examples of items are, "I am very committed to this friendship" and "I have a a very strong relationship with my friend". The 22 item scale have a Cronbach's alpha of .97 for participants and .96 for friends. Friends and participants agreed on the quality of their friendship,  $r = .32$ ,  $p = .02$ . Mean of participant friendship quality was 4.92 ( $sd = 0.89$ ) and mean of friend friendship quality was 4.86 ( $sd = 0.82$ ). See Appendix C for all items.

**Perceived social support.** A nine-item measure from Sherbourne and Stewart (1991) of participants perceived social support using a five point Likert scale. All items follow from the instruction of "How often is each of the following kinds of support available to you if you need it?" and an example of one item is "Someone to give you good advice about a crisis". The shortened scale has a Cronbach's alpha of .90 (Caley, Struthers, Stafford, & Lehman, 2018). Mean of participant perceived social support was 4.37 ( $sd = 0.66$ ) and mean of friend perceived social support was 4.12 ( $sd = 0.57$ ). See Appendix D for all items.

**Social evaluation.** A three-item measure of participants feeling of being negatively evaluated by the friend participants brought to the study. The items are "My friend seemed to

think I would do fine during this presentation,” “My friend seemed to think I had a hard time during this presentation,” and “I was worried about what my friend was thinking about me during this presentation” are rated on a five point scale from 1 (*strongly disagree*) to 5 (*strongly agree*); higher values indicate more social evaluative concern. These items were adapted from Kirsch and Lehman (2014). Shown in Appendix E. See Table 6 for descriptive statistics

**Discrete emotions measure.** A 16-item measure of discrete positive and negative emotions that include items that are both high activation (e.g. anger, excitement) and low activation (e.g. sad, calm) as well as self-conscious emotions (e.g. embarrassment, shame) taken from the PANAS measure (Watson, Clark, & Tellegen, 1988). Some positive and negative emotion items are from Russell and Feldman-Barrett (1999) and Diener, Smith, and Fujita (1995). All items are rated using a seven point scale from 1 (*not at all*) to 7 (*extremely*); higher values indicate more positive emotions. See Table 6 for descriptive statistics. The full measure is shown in Appendix F.

**Threat versus challenge appraisal.** A 17-item of threat and challenge appraisal adapted from Gaab, Rohleder, Rater, and Ehlert’s (2005) PASA measure and Tomaka, Blascovitch, Kelsey, and Letten (1993) and Tomaka et al. (1999). The questions are designed to determine how much a participant views the presentation as important, how much demand they feel, and if they feel they have the required resources to meet the demand. Item response is on a seven point Likert scale from 1 (*Not at all*) to 7 (*Very much so*); higher values indicate for challenge appraisals. An example of an item is “Presentations are stressful for me.” See Appendix G for a list of all items. See Table 6 for descriptive statistics

### ***Overview of Statistical Analyses***

Task engagement and task stressfulness were examined first in order to determine that two basic experimental conditions were established. Participants' task engagement was determined by analyzing the response to the "topic importance" item. Task stressfulness was examined by analyzing changes in cardiovascular and psychological responses from baseline to reactivity. This was done to determine if our anticipated speech task actually elicited a stress response from participants. Data analysis and presentation of results closely follows Kirsch (2012).

Once it was determined that the anticipated speech task elicited a stress response, the social support models were tested to determine if social support moderated the stress response for participants. First tested was social support Model 1, which compared both the in-person and text-messaged social support conditions to the control condition. Model 1 tested the hypothesis that participants who receive social support would show reduced psychological and cardiovascular reactivity to a stressor, in addition to recovering quicker than participants who do not receive social support. Social support Model 2 compared the text-messaged social support condition to the control condition and social support Model 3 compared the in-person social support to the control condition. Model 2 tested the hypothesis that participants who receive text-messaged social support would show reduced psychological and cardiovascular reactivity to a stressor, in addition to recovering quicker than participants who did not receive social support. Model 3 tested the hypothesis that participants who received in-person social support would show reduced psychological and cardiovascular reactivity to the stressor, in addition to recovering quicker than participants who did not receive social support. It is important to note that social support Models 2 and 3 were only analyzed for the cardiovascular and psychological

parameters that were statistically significant in social support Model 1. Table 1 illustrates the contrast codes that were used to test the three models.

Table 1

*Test of Social Support Manipulation Contrast Codes*

Model Tested	Support Condition		
	In-Person	Text-Message	Control
Model 1: SS vs Control	1	1	-2
Model 2: Text-MSG SS vs Control	0	1	-1
Model 3: In-Person SS vs Control	1	0	-1

*Statistical Strategy for Cardiovascular and Psychological Responses*

Hierarchical linear modeling (HLM) was used to test the overall stressfulness of the anticipated speech task and to test if social support, both in-person and text-messaged, attenuated cardiovascular and psychological reactivity from the anticipated speech task. HLM uses maximum likelihood estimation to conduct mixed-effects regression with nested data.

The data collected during the laboratory sessions are best conceptualized in two levels. Level 1 variables are the nine cardiovascular readings and nine psychological self report measures taken throughout the laboratory session. Level 1 variables vary within individuals over time. Level 2 variables include social support condition (in-person, text-message, none) and demographic variables. Level 2 variables varied between participants. Cardiovascular (SBP, DBP, HR) and psychological (SET, Challenge appraisal, Positive emotions) parameters were analyzed as separate Level 1 outcome variables. Random effects were tested and kept in the model only if they predicted the outcome at  $p < .10$  (Conley & Lehman, 2010). Note that degrees

of freedom were approximately 47 for tests of random effects and 379 for tests of fixed effects. Normal standard errors are reported since all cardiovascular parameters were normally distributed. The procedure used to test these models are described in more detail below.

**Test of Task Stressfulness:** The first step tested whether participants experienced elevated cardiovascular and psychological responses during the study. To test the Level 1 cardiovascular measures (HR, SBP, DBP) and psychological measures (SET, Challenge appraisal, Positive emotions) a set of new variables containing contrast codes were created following the procedures outlined in Lehman, Kirsch, & Jones (2015). These variables were used to test whether participants showed elevated cardiovascular and psychological readings during the speech preparation and practice phase (defined as reactivity) and whether they had lower cardiovascular and psychological readings after being told that they did not have to give a final speech to a panel of judges (defined as recovery). As shown in Table 2, four cardiovascular and psychological self report responses were completed during the reactivity period and three cardiovascular and psychological self report responses were completed during the recovery period.

For each task period (reactivity and recovery) a series of theorized patterns of change (magnitude change, linear slope, quadratic curve) was tested. For modeling magnitude change, values for task periods under consideration were given a value of 1 while other periods were given a value of 0. For example, to model magnitude change for recovery the three time periods of recovery were given a code of 1 and all other measures obtained at baseline and reactivity were coded as 0. For linear slope, values were contrast codes created to represent linear relationships centered on the middle of the task periods under consideration. For example, under

reactivity the first reading was given a code of -3, the second a code of -1, the third a code of 1, and the fourth a code of 3. For quadratic curve, the contrast codes represented a quadratic relationship centered with positive values in the middle of the task period, creating an inverted U shape. To code for linear slope reactivity the first reading was given a code of -1, the second a code of 1, the third a code of 1, and the fourth a code of -1. Quadratic curve was not tested for recovery as we expected the relationship to be a negative linear slope since responses should decrease over time. See Table 2 for all of the contrast codes for reactivity and recovery. All three reactivity models (magnitude change, linear slope, quadratic curve) were entered simultaneously for each of the three cardiovascular measures (HR, SBP, DBP) and the three psychological scales (SET, Challenge appraisal, Positive emotions). A set of six different analyses were used to simultaneously test magnitude change, linear slope, and quadratic curve.

**Test of Social Support:** Social support was a contrast coded variable entered at Level 2 and tested whether the three different social support models moderated cardiovascular (HR, SBP, DBP) and psychological (SET, Challenge appraisal, Positive emotions) responses to the anticipated speech task. As described above, a series of contrast-coded variables that corresponded to the response patterns magnitude change, linear slope, and quadratic curve were entered at Level 1, and SS models were entered as Level 2 moderators of those Level 1 effects.



Table 2

*Growth Curve Contrast Codes Entered at Level 1*

Cardiovascular and Psychological Readings									
Baseline		Prep/Practice		Practice		Recovery			
1	2	1	2	3	4	1	2	3	
Contrast Codes: Test of Task Stressfulness									
Baseline		Reactivity				Recovery			
Period Modeled at Level 1									
Reactivity									
1. Magnitude Change	0	0	1	1	1	1	0	0	0
2. Linear Slope	0	0	-3	-1	1	3	0	0	0
3. Quadratic Curve	0	0	-1	1	1	-1	0	0	0
Recovery									
1. Magnitude Change	0	0	0	0	0	0	1	1	1
2. Linear Slope	0	0	0	0	0	0	-1	0	1

**Results****Data Screening*****Cardiovascular Responses***

Following standard screening procedures, the cardiovascular responses were first examined for biologically improbable readings (Marler et al., 1988). Based on screening, one biologically improbable heart rate reading was removed from the sample. The three cardiovascular parameters (HR, SBP, DBP) were graphed to check for non-normality and for outliers. All three parameters were normally distributed.

### ***Tests of Group Differences***

Three different one-way ANOVAs were used to compare participant responses to a series of items designed to assess group differences across the three conditions. The three items tested were: topic importance ( $F(2, 46) = 0.10, p = .90.$ ), study importance ( $F(2, 46) = 0.10, p = .90.$ ), and interested in the study ( $F(2, 46) = 0.10, p = .90.$ ). A chi-square test was also used to determine whether a family history of hypertension varied based on social support condition,  $\chi^2(4, n = 49) = 4.09, p = .39$ . Although there were no group differences found across the three one-way ANOVAs results suggest that participants were engaged in the study. Topic importance had a mean of 2.88 ( $sd = 0.95$ ) with a range of 1 to 4. Study importance had a mean of 3.49 ( $sd = 0.82$ ) with a range of 1 to 5. Interested in study had a mean of 4.04 ( $sd = 0.68$ ) with a range of 1 to 5. Participants must view themselves as invested in the study in order for stress tasks to be successful.

A series of one-way ANOVAs was also conducted to determine if there were any group differences in the three conditions on the measures of perceived social support (PSS) and friendship quality for friends and participants. There were no group differences in PSS or friendship quality for either friends or participant reports. PSS-Participant,  $F(2, 46) = 0.33, p = .72$ ; PSS-Friend,  $F(2, 46) = 0.33, p = .73$ ; Friendship Quality-Participant,  $F(2, 46) = 0.27, p = .72$ ; Friendship Quality-Friend,  $F(2, 46) = 0.70, p = .95$ .

### **Test of Task Stressfulness: Changes in Cardiovascular and Psychological Responses**

#### ***Cardiovascular Responses***

A hierarchical growth curve model tested the stress task manipulation. The three theorized patterns (magnitude change, linear slope, and quadratic curve) were entered

simultaneously as Level 1 predictors of cardiovascular responses at reactivity and then at recovery. Table 3 shows the descriptive statistics of cardiovascular responses obtained for each reading and Table 4 has the results of the hierarchical growth curve models tested for each of the cardiovascular parameters (SBP, DBP, HR). See Figure 1-3 for graphs of the cardiovascular responses.

Figure 1

*Systolic Blood Pressure Means Pattern*

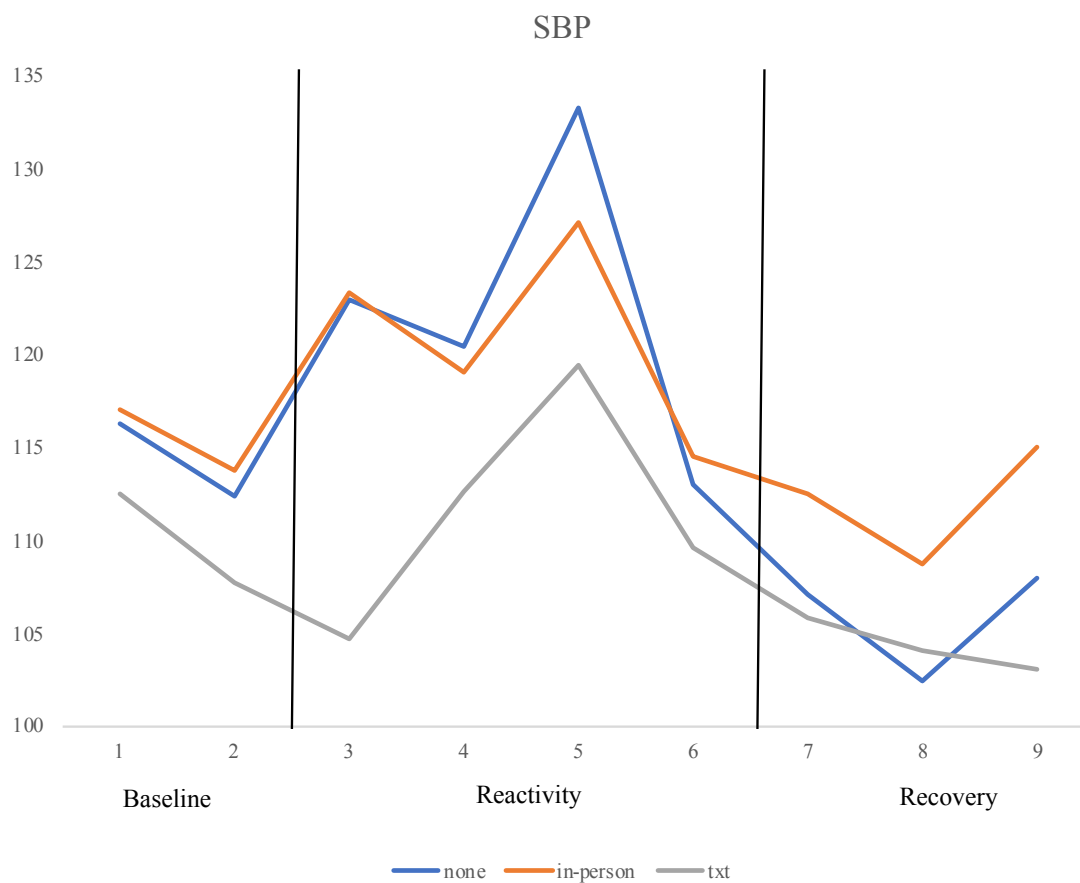


Figure 2

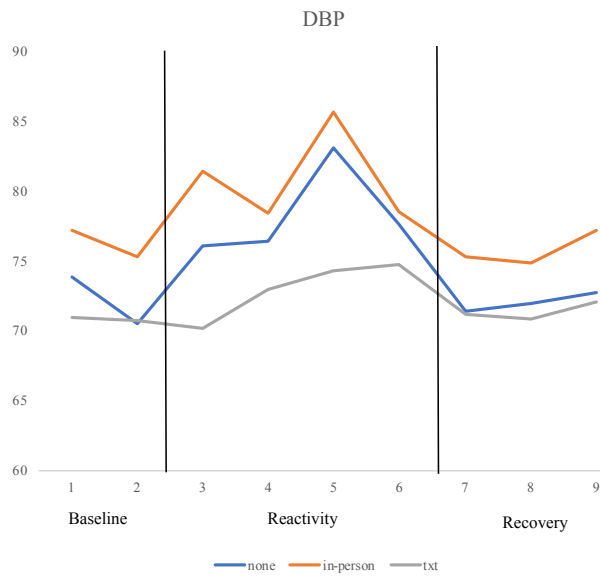
*Diastolic Blood Pressure Means Pattern*

Figure 3

*Heart Rate Means Pattern*

Table 3

*Cardiovascular Descriptive Statistics*

Parameter	Cardiovascular Readings: Mean (SD)								
	Baseline		Prep/Practice		Practice		Recovery		
	1	2	1	2	3	4	1	2	3
SBP	115.18 (10.06)	111.10 (10.17)	117.84 (14.82)	117.44 (13.46)	127.07 (13.74)	112.37 (10.02)	108.39 (11.12)	105.03 (10.22)	109.27 (9.88)
DBP	73.79 (6.38)	71.90 (6.26)	76.13 (8.86)	75.84 (6.11)	81.03 (8.86)	76.91 (7.88)	72.61 (8.49)	72.51 (5.08)	74.27 (5.62)
HR	82.11 (14.63)	83.05 (11.89)	82.48 (16.48)	81.88 (15.60)	86.07 (14.13)	75.74 (13.92)	74.75 (11.73)	73.18 (9.47)	75.76 (11.37)

Table 4

*Test of Stress Task: Piecewise Growth Curve Models of Cardiovascular Parameters*

Task Period Modeled	Predictors	Systolic Blood Pressure		Diastolic Blood Pressure		Heart Rate	
		Coefficient (SE)	<i>p</i>	Coefficient (SE)	<i>p</i>	Coefficient (SE)	<i>p</i>
Reactivity	Intercept	109.85 (1.37) <sup>a</sup>	<.001	73.01 (0.95) <sup>a</sup>	<.001	77.36 (1.63) <sup>a</sup>	<.001
	Magnitude Change	9.25 (1.16) <sup>a</sup>	<.001	4.87 (0.79) <sup>a</sup>	<.001	3.97 (1.02) <sup>a</sup>	<.001
	Linear Slope	-0.45 (0.29)	.123	0.34 (0.29) <sup>a</sup>	.242	-0.68 (0.29) <sup>a</sup>	.025
	Quadratic Curve	3.38 (0.84) <sup>a</sup>	<.001	1.07 (0.51) <sup>a</sup>	.04	1.51 (0.89) <sup>a</sup>	.098
Recovery	Intercept	116.37 (1.46) <sup>a</sup>	<.001	75.83 (0.86) <sup>a</sup>	<.001	81.15(1.75) <sup>a</sup>	<.001
	Magnitude Change	-8.51 (1.13)	<.001	-2.74 (0.58)	<.001	-6.60 (0.93)	<.001
	Linear Slope	-0.14 (0.62)	.826	0.66 (0.47)	.157	-.12 (0.72)	.864

Note: <sup>a</sup> = slopes that were set to random

Bold *p* values indicate that the growth curve patterns significantly predicted the observed cardiovascular responses.

**Reactivity.** At the reactivity period, cardiovascular responses increased during the anticipated speech task. For SBP, both magnitude change,  $t(48) = 7.96$ ,  $p < .001$ , and quadratic

curve,  $t(48) = 4.04, p < .001$ , predicted responses. Linear slope did not predict SBP responses,  $t(171) = -1.55, p = .123$ . Magnitude change,  $t(48) = 6.20, p < .001$ , and quadratic curve,  $t(48) = 2.11, p = .04$ , significantly predicted DBP responses. Linear slope did not predict DBP responses,  $t(48) = 1.18, p = .242$ . For HR, linear slope,  $t(48) = -2.71, p = .025$ , and magnitude change,  $t(48) = 3.90, p < .001$ , significantly predicted responses. Quadratic curve,  $t(48) = 1.89, p = .098$ , did not predict HR responses. The statistically significant results for reactivity magnitude change reflects significantly higher SBP, DBP, and HR at reactivity relative to the baseline and recovery task periods. And the statistically significant results for quadratic curve at DBP and SBP indicated that responses were elevated at the beginning of the presentation, stabilized during the middle, and then declined towards the end of the presentation. The statistically significant linear slope result for HR indicated that heart rate was elevated at the start of the presentation and then declined towards the end of the reactivity task period.

**Recovery.** At the recovery period, cardiovascular responses decreased after participants were relieved from the expected presentation. Heart rate,  $t(267) = -7.08, p < .001$ , SBP,  $t(268) = -7.55, p < .001$ , and DBP,  $t(277) = -4.71, p < .001$ , were negatively statistically significantly predicted by magnitude change. Linear recovery slope was not statistically consistent with any of the three cardiovascular parameters: SBP,  $t(268) = -0.22, p = .826$ ; DBP,  $t(277) = 1.42, p = .157$ ; HR,  $t(267) = -0.17, p = .864$ . Quadratic curve was not tested for the recovery period as we did not believe it would predict any of the cardiovascular parameters. The statistically significant results for magnitude change reflects significantly lower SBP, DBP, and HR at recovery relative to the baseline and reactivity task periods.

### *Psychological Responses*

A hierarchical growth curve model again tested the effects of stress task manipulation on psychological responses. The three theorized patterns (magnitude change, linear slope, and quadratic curve) were entered simultaneously as Level 1 predictors of psychological responses at reactivity and recovery. Table 5 shows the descriptive statistics of psychological responses obtained for each reading and Table 6 has the results of the hierarchical growth curve models tested for each of the psychological parameters (SET, Challenge appraisal, Positive emotions). See Figures 4-6 for graphs of the psychological responses.

Figure 4

#### *Social Evaluative Threat Means Pattern*



Figure 5

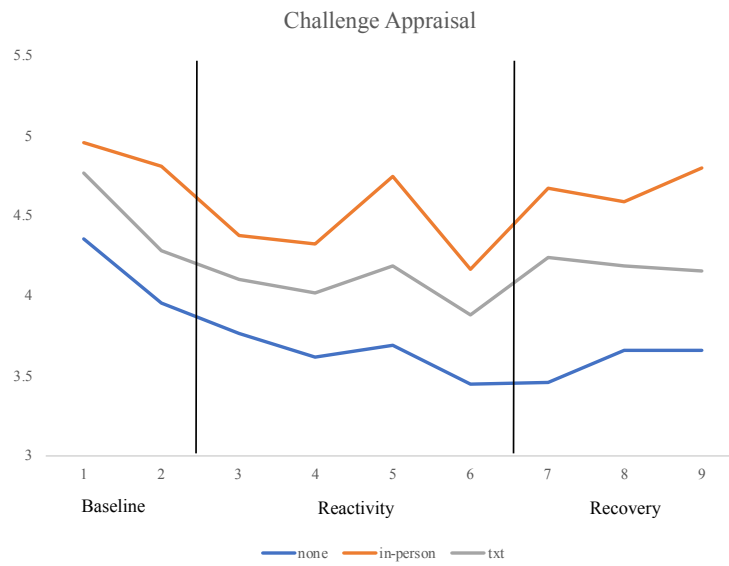
*Challenge Appraisal Means Pattern*

Figure 6

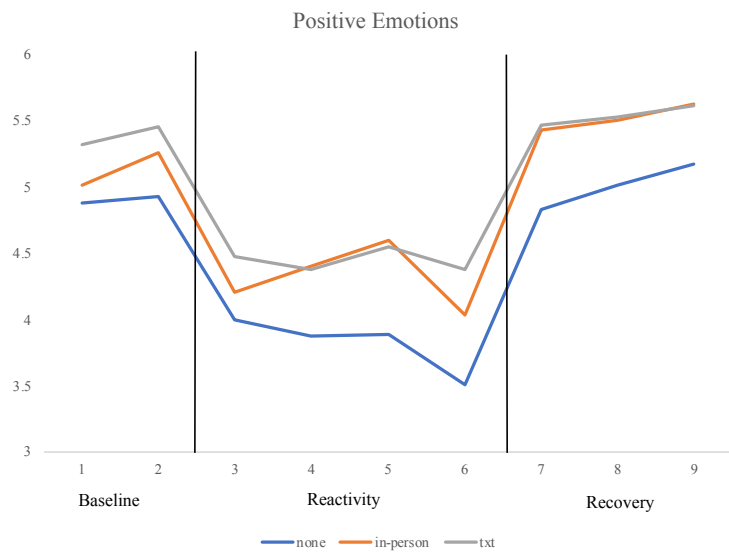
*Positive Emotions Means Pattern*



Table 5

*Psychological Descriptive Statistics*

Parameter	Psychological Readings: Mean (SD)								
	Baseline		Prep/Practice		Practice		Recovery		
	1	2	1	2	3	4	1	2	3
SET	2.18 (0.69)	2.08 (0.76)	2.49 (0.82)	2.20 (0.88)	2.28 (0.85)	2.38 (0.87)	2.19 (0.93)	2.13 (0.89)	2.10 (0.83)
Challenge Appraisal	4.57 (0.80)	4.32 (0.89)	4.07 (1.12)	3.98 (1.23)	4.17 (1.20)	3.82 (1.11)	4.11 (1.09)	4.12 (1.15)	4.18 (1.12)
Positive Emotion	5.08 (0.65)	5.22 (0.63)	4.24 (1.17)	4.22 (1.21)	4.34 (1.13)	3.99 (1.22)	5.24 (0.89)	5.35 (0.77)	5.47 (0.80)

Note. SET = 1 (*strongly disagree*) to 5 (*strongly agree*); Challenge appraisal = 1 (*not at all*) to 7 (*very much so*); Positive emotion = 1 (*not at all*) to 7 (*extremely*).

Table 6

*Test of Stress Task: Piecewise Growth Curve Models of Psychological Parameters*

Task Period Modeled	Predictors	Social Evaluative Threat		Challenge Appraisals		Positive Emotions	
		Coefficient (SE)	<i>p</i>	Coefficient (SE)	<i>p</i>	Coefficient (SE)	<i>p</i>
Reactivity	Intercept	2.13 (0.10) <sup>a</sup>	<b>&lt;.001</b>	4.25 (.12) <sup>a</sup>	<b>&lt;.001</b>	5.27 (.09) <sup>a</sup>	<b>&lt;.001</b>
	Magnitude Change	0.20 (0.06) <sup>a</sup>	<b>&lt;.001</b>	-0.25 (0.11) <sup>a</sup>	<b>.029</b>	-1.08 (0.13) <sup>a</sup>	<b>&lt;.001</b>
	Linear Slope	-0.01 (0.01)	.246	-0.03 (0.01)	<b>.015</b>	-0.03 (0.02)	.171
	Quadratic Curve	-0.10 (0.03)	<b>&lt;.001</b>	0.06 (0.03)	<b>.019</b>	0.08 (0.03)	<b>.004</b>
Recovery	Intercept	2.27 (.10) <sup>a</sup>	<b>&lt;.001</b>	4.15 (0.13) <sup>a</sup>	<b>&lt;.001</b>	4.52 (0.12) <sup>a</sup>	<b>&lt;.001</b>
	Magnitude Change	-0.13 (0.06) <sup>a</sup>	<b>.024</b>	-0.02 (0.11) <sup>a</sup>	.84	0.84 (0.12) <sup>a</sup>	<b>&lt;.001</b>
	Linear Slope	-0.05 (.02)	<b>.017</b>	.04 (.04)	.35	0.11 (0.04)	<b>.002</b>

Note: SET measure was set so that higher numbers equaled more SET. Challenge appraisal measure was set so that higher number equals more challenge appraisals. Positive emotions measure was set so that higher number equals more positive emotions.

<sup>a</sup>= slopes that were set to random

Bold *p* values indicate that the growth curve patterns significantly predicted the observed psychological responses.

**Reactivity.** At the *reactivity* period, negative psychological responses increased in response to the anticipated speech task. Social evaluative threat was statistically significantly predicted by magnitude change,  $t(48) = 3.51, p < .001$ , and quadratic curve,  $t(332) = -3.46, p < .001$ . Linear slope did not predict SET responses,  $t(332) = -1.16, p = .246$ . For challenge appraisal, magnitude change,  $t(48) = -2.26, p = .029$ , quadratic curve,  $t(332) = 2.35, p = .019$ , and linear slope,  $t(332) = -2.45, p = .015$ , statistically significantly predicted responses. For positive emotions, both magnitude change,  $t(48) = -8.42, p < .001$ , and quadratic curve,  $t(284) = 2.89, p = .004$ , statistically significantly predicted responses. Linear slope,  $t(48) = -1.39, p = .171$ , did not significantly predict responses. The statistically significant results for magnitude change reflects significantly increased SET and significantly decreased challenge appraisals and positive emotions at reactivity relative to the baseline and recovery task periods. And the statistically significant results for quadratic curve at SET, challenge appraisal, and positive emotions indicated that participants had lower reactivity at the beginning of the presentation and then stabilized during the middle and then declined towards the end of the presentation. The statistically significant linear slope result for challenge appraisals indicated that participants reported higher challenge appraisals at the start of the presentation and then lower towards the end.

**Recovery.** At the *recovery* period, negative psychological responses decreased after participants were told they did not have to do the presentation. Positive emotions,  $t(48) = 6.95, p < .001$ , and SET,  $t(48) = -2.33, p = .024$ , were statistically significantly predicted by magnitude change, while challenge appraisals,  $t(48) = -0.20, p = .84$ , was not. Linear slope was negatively statistically significantly predicted for SET,  $t(186) = -2.40, p = .02$ , and positively significantly

predicted by positive emotions,  $t(48) = 3.11, p = .003$ . Challenge appraisals were not predicted by linear slope,  $t(48) = 0.93, p = .36$ . Quadratic curve was not tested for the recovery period as we did not believe it would predict any of the psychological parameters. The statistically significant results for linear slope reflects significantly lower SET and greater positive emotions at recovery. While the statistically significant results for magnitude change reflects significantly more positive emotions and significantly lower SET at recovery relative to the baseline and reactivity task periods.

### **Test of Social Support Manipulation Models**

#### ***Test of Social Support Model 1 (in-person and text-messaged conditions vs control condition)***

**Cardiovascular Responses:** The dummy-coded variable that corresponded to the prediction of social support Model 1 was tested as a moderator of the cardiovascular patterns of magnitude change, linear slope, and quadratic curve. See Table 8 for the results of the hierarchical linear model for the cardiovascular parameters of SBP, DBP, and HR.

**Reactivity.** The *reactivity* task period was analyzed to test social support Model 1, which examined whether the comparison of any social support to no social support moderated any of the cardiovascular patterns. For SBP, magnitude change was negatively statistically significantly moderated by the model,  $t(47) = -2.13, p = .038$ . This result indicates that participants who received social support had lower SBP during reactivity compared to participants who did not receive social support. The social support model did not moderate magnitude change for DBP,  $t(47) = -1.40, p = .167$ , or HR,  $t(47) = -1.67, p = .102$ . Nor did the model moderate linear slope for SBP,  $t(170) = 0.05, p = .962$ , DBP,  $t(47) = -1.14, p = .259$ , or HR,  $t(47) = -0.41, p = .688$ .

Quadratic curve did not moderate the model for SBP,  $t(47) = 0.43, p = .668$ , DBP,  $t(47) = -0.89, p = .378$ , or HR,  $t(47) = -0.66, p = .512$ .

**Recovery.** For the *recovery* task period, SBP magnitude change positively and statistically significantly moderated by the model,  $t(266) = 2.96, p = .003$ . This result indicates that participants who received social support had higher SBP during recovery compared to participants who did not receive support. The social support model did not significantly moderate magnitude change for DBP,  $t(275) = 1.16, p = .246$ , or HR,  $t(265) = 1.02, p = .310$ . Additionally, social support did not moderate linear slope for SBP,  $t(266) = 0.79, p = .431$ , DBP,  $t(275) = 0.21, p = .838$ , or HR,  $t(265) = 1.82, p = .069$ .

**Psychological Responses:** The dummy-coded variable that corresponded to the prediction of social support Model 1 was tested as a moderator of the psychological patterns of magnitude change, linear slope, and quadratic curve. See Table 9 for the results of the hierarchical linear model for the cardiovascular parameters of SET, challenge appraisal, and positive emotion.

**Reactivity.** The *reactivity* task period was analyzed to test if social support Model 1 moderated any of the psychological patterns. The SET quadratic curve was negatively statistically significantly moderated by the model,  $t(330) = -2.29, p = .023$ . This result indicates that participants who received social support had lower SET during reactivity compared to participants who did not receive social support. The social support model did not moderate magnitude change for SET,  $t(47) = -1.13, p = .263$ , challenge appraisal,  $t(47) = -0.44, p = .659$ , or positive emotion,  $t(47) = 0.26, p = .794$ . Nor did the model moderate linear slope for SET,  $t(330) = -1.33, p = .184$ , challenge appraisal,  $t(330) = 1.53, p = .126$ , or positive emotion,  $t(330)$

= 1.33,  $p = .185$ . The social support model did not moderate quadratic curve for challenge appraisal,  $t(330) = 0.51$ ,  $p = .608$ , or positive emotion,  $t(330) = -0.04$ ,  $p = .966$ .

**Recovery.** For the *recovery* task period, SET magnitude change was negatively statistically significantly moderated by the model,  $t(47) = -2.93$ ,  $p = .005$ . This pattern indicates that participants who received social support reported lower SET during recovery compared to participants who did not receive support. The social support model did not significantly moderate magnitude change for challenge appraisal,  $t(47) = 1.23$ ,  $p = .223$ , or positive emotion,  $t(47) = 0.05$ ,  $p = .959$ . Additionally, social support did not moderate linear slope for SET,  $t(332) = 0.68$ ,  $p = .494$ , challenge appraisal,  $t(332) = -1.36$ ,  $p = .176$ , or positive emotion,  $t(332) = -1.04$ ,  $p = .299$ .

Table 7

## Hierarchical Linear Modeling of Cardiovascular Parameters: Social Support Model 1

Predictors	SBP		DBP		HR	
	Coefficient (SE)	<i>p</i>	Coefficient (SE)	<i>p</i>	Coefficient (SE)	<i>p</i>
Reactivity: Intercept						
<i>Intercept</i>	109.86 (1.38) <sup>a</sup>	<.001	73.06 (0.97) <sup>a</sup>	<.001	77.33 (1.61) <sup>a</sup>	<.001
Soc. Support	0.23 (0.90) <sup>a</sup>	.795	0.58 (0.60) <sup>a</sup>	.34	-0.24 (1.18) <sup>a</sup>	.839
Reactivity: Magnitude Change						
<i>Intercept</i>	9.08 (1.15) <sup>a</sup>	<.001	4.86 (0.79) <sup>a</sup>	<.001	3.92 (1.0) <sup>a</sup>	<.001
Soc. Support	<b>-1.51 (0.71) <sup>a</sup></b>	<b>.038</b>	-0.76 (0.54) <sup>a</sup>	.167	-1.04 (0.62) <sup>a</sup>	.102
Reactivity: Linear Slope						
<i>Intercept</i>	-0.39 (0.31)	.215	0.33 (0.31) <sup>a</sup>	.289	-0.66 (0.29) <sup>a</sup>	.029
Soc. Support	0.01 (0.20)	.962	-0.23 (0.20) <sup>a</sup>	.259	-0.08 (0.20) <sup>a</sup>	.688
Reactivity: Quadratic Curve						
<i>Intercept</i>	3.38 (0.88) <sup>a</sup>	<.001	0.96 (0.54) <sup>a</sup>	.082	1.37 (0.93) <sup>a</sup>	.148
Soc. Support	0.23 (0.54) <sup>a</sup>	.668	-0.29 (0.33) <sup>a</sup>	.378	-0.40 (0.61) <sup>a</sup>	.512
Recovery: Intercept						
<i>Intercept</i>	116.27 (1.41) <sup>a</sup>	<.001	75.84 (0.86) <sup>a</sup>	<.001	81.08 (1.72) <sup>a</sup>	<.001
Soc. Support	-1.29 (1.02) <sup>a</sup>	.211	0.08 (0.58) <sup>a</sup>	.888	-0.88 (1.25) <sup>a</sup>	.486
Recovery: Magnitude Change						
<i>Intercept</i>	-8.38 (1.05)	<.001	-2.71 (0.57)	<.001	-6.56 (0.94)	<.001
Soc. Support	<b>2.06 (0.70)</b>	<b>.003</b>	0.46 (0.40)	.246	0.64 (0.63)	.310
Recovery: Linear Slope						
<i>Intercept</i>	-0.11 (0.63)	.860	0.67 (0.47)	.152	-0.09 (0.71)	.897
Soc. Support	0.32 (0.40)	.431	0.06 (0.30)	.838	0.84 (0.46)	.069

Note: <sup>a</sup> = slopes that were set to random

Bold *p* values indicate that the growth curve patterns significantly predicted the observed cardiovascular responses.

Table 8

## Hierarchical Linear Modeling of Psychological Parameters: Social Support Model 1

Predictors	SET		Challenge Appraisal		Positive Emotions	
	Coefficient (SE)	<i>p</i>	Coefficient (SE)	<i>p</i>	Coefficient (SE)	<i>p</i>
Reactivity: Intercept						
<i>Intercept</i>	2.12 (0.09) <sup>a</sup>	<.001	4.28 (0.12) <sup>a</sup>	<.001	5.28 (0.08) <sup>a</sup>	<.001
Soc. Support	<b>-0.19 (0.06) <sup>a</sup></b>	<b>.005</b>	<b>0.21 (0.07) <sup>a</sup></b>	<b>.002</b>	<b>0.15 (0.06) <sup>a</sup></b>	<b>.016</b>
Reactivity: Magnitude Change						
<i>Intercept</i>	0.20 (0.06) <sup>a</sup>	.001	-0.26 (0.11) <sup>a</sup>	.024	-1.08 (0.13) <sup>a</sup>	<.001
Soc. Support	-0.04 (0.04) <sup>a</sup>	.263	-0.04 (0.09) <sup>a</sup>	.659	0.02 (0.09) <sup>a</sup>	.794
Reactivity: Linear Slope						
<i>Intercept</i>	-0.02 (0.01)	.192	-0.03 (0.01)	.017	-0.03 (0.02)	.203
Soc. Support	-0.01 (0.009)	.184	0.01 (0.007)	.126	0.02 (0.02)	.185
Reactivity: Quadratic Curve						
<i>Intercept</i>	-0.10 (0.03)	<.001	0.06 (0.03)	.018	0.09 (0.03)	.004
Soc. Support	<b>-0.03 (0.02)</b>	<b>.023</b>	0.009 (0.02)	.608	-0.0008 (0.02)	.966
Recovery: Intercept						
<i>Intercept</i>	2.25 (0.09) <sup>a</sup>	<.001	4.17 (0.13) <sup>a</sup>	<.001	4.53 (0.12) <sup>a</sup>	<.001
Soc. Support	<b>-0.17 (0.06) <sup>a</sup></b>	<b>.008</b>	0.16 (0.08) <sup>a</sup>	.058	0.15 (0.08) <sup>a</sup>	.052
Recovery: Magnitude Change						
<i>Intercept</i>	-0.14 (0.05) <sup>a</sup>	.013	-0.02 (0.11) <sup>a</sup>	.875	0.84 (0.12) <sup>a</sup>	<.001
Soc. Support	<b>-0.10 (0.03) <sup>a</sup></b>	<b>.005</b>	0.10 (0.08) <sup>a</sup>	.223	0.005 (0.09) <sup>a</sup>	.959
Recovery: Linear Slope						
<i>Intercept</i>	-0.05 (0.02)	.016	0.04 (0.04)	.376	0.11 (0.04)	.002
Soc. Support	0.01 (0.02)	.494	-0.03 (0.03)	.176	-0.03 (0.03)	.299

Note: <sup>a</sup> = slopes that were set to random

Bold *p* values indicate that the growth curve patterns significantly predicted the observed psychological responses.

***Test of Social Support Model 2 (text-messaged social support condition vs control condition)***

**Cardiovascular Responses:** Because SBP magnitude change during reactivity and recovery was statistically significantly moderated by social support Model 1, SBP was then analyzed using the remaining two social support models. The dummy-coded variable that corresponded to the prediction of social support Model 2, which examined text messaged social support compared to no social support was tested as a moderator of the cardiovascular patterns of magnitude change, linear slope, and quadratic curve during reactivity and recovery. See Table 10 for the results of the hierarchical linear model for the cardiovascular parameter of SBP for Model 2.

***Reactivity.*** For the *reactivity* task period, SBP magnitude change was negatively statistically significantly moderated by Model 2,  $t(47) = -2.40, p = .02$ . Which indicates that participants who received text-messaged social support had lower SBP during reactivity compared to participants who did not receive support. Social support Model 2 did not significantly moderate linear slope,  $t(170) = 1.24, p = .218$  or quadratic curve,  $t(47) = 0.99, p = .324$ , for SBP.

***Recovery.*** For the *recovery* task period, SBP magnitude change was positively statistically significantly moderated by Model 2,  $t(266) = 2.49, p = .014$ . Which indicates that participants who received text-messaged social support had higher SBP during recovery compared to participants who did not receive support. Social support Model 2 did not significantly moderate linear slope for SBP,  $t(266) = 0.38, p = .702$ .

**Psychological Responses:** Because SET quadratic curve during reactivity and SET magnitude change during recovery were statistically significantly moderated by social support



Model 1, SET was then analyzed using the remaining two social support models. The dummy-coded variable that corresponded to the prediction of social support Model 2 was tested as a moderator of the SET patterns of magnitude change, linear slope, and quadratic curve during reactivity and recovery. See Table 11 for the results of the hierarchical linear model for the psychological parameter of SET for Model 2.

**Reactivity.** For the *reactivity* task period, SET was not moderated by social support Model 2 at all. Magnitude change,  $t(47) = -0.33, p = .742$ , linear slope,  $t(330) = -0.46, p = .645$ , and quadratic curve,  $t(330) = -1.18, p = .238$ . These results do not support the hypothesis that participants who receive text-messaged social support would have reduced psychological reactivity during the stressor.

**Recovery.** For the *recovery* task period, SET magnitude change was negatively statistically significantly moderated by the Model,  $t(47) = -2.29, p = .027$ . Which indicates that participants who received text-messaged social support reported lower SET during recovery compared to participants who did not receive support. The social support did not moderate linear slope for SET,  $t(332) = 0.21, p = .832$ .

Table 9

## Hierarchical Linear Modeling of Cardiovascular Parameters: Social Support Models 2 &amp; 3

Predictors	SBP			
	Model 2: Text vs. Control		Model 3: In-person vs. Control	
	Coefficient (SE)	<i>p</i>	Coefficient (SE)	<i>p</i>
Reactivity: Intercept				
<i>Intercept</i>	109.83 (1.36) <sup>a</sup>	<.001	109.98 (1.33) <sup>a</sup>	<.001
Soc. Support	-1.33 (1.66) <sup>a</sup>	.425	2.17 (1.44) <sup>a</sup>	.139
Reactivity: Magnitude				
<i>Intercept</i>	9.05 (1.12) <sup>a</sup>	<.001	9.17 (1.21) <sup>a</sup>	<.001
Soc. Support	<b>-2.45 (1.02) <sup>a</sup></b>	<b>.02</b>	-2.19 (1.61) <sup>a</sup>	.179
Reactivity: Linear Slope				
<i>Intercept</i>	-0.37 (0.31)	.226	-0.42 (0.29)	.144
Soc. Support	0.44 (0.36)	.218	-0.36 (0.32)	.261
Reactivity: Quadratic Curve				
<i>Intercept</i>	3.53 (0.88) <sup>a</sup>	<.001	3.23 (0.86) <sup>a</sup>	<.001
Soc. Support	1.03 (1.04) <sup>a</sup>	.324	-0.34 (0.95) <sup>a</sup>	.719
Recovery: Intercept				
<i>Intercept</i>	116.29 (1.37) <sup>a</sup>	<.001	116.38 (1.42) <sup>a</sup>	<.001
Soc. Support	-3.43 (1.77) <sup>a</sup>	.059	-0.41 (1.63) <sup>a</sup>	.80
Recovery: Magnitude Change				
<i>Intercept</i>	-8.40 (1.09)	<.001	-8.44 (1.03)	<.001
Soc. Support	<b>2.54 (1.02)</b>	<b>.014</b>	<b>3.71 (1.41)</b>	<b>.009</b>
Recovery: Linear Slope				
<i>Intercept</i>	-0.10 (0.64)	.876	-0.20 (0.62)	.75
Soc. Support	0.29 (0.77)	.702	0.57 (0.68)	.406

Note: <sup>a</sup> = slopes that were set to random

Bold *p* values indicate that the growth curve patterns significantly predicted the observed cardiovascular responses.

Table 10

## Hierarchical Linear Modeling of Psychological Parameters: Social Support Models 2 &amp; 3

Predictors	SET			
	Model 2: Text vs. Control		Model 3: In-person vs. Control	
	Coefficient (SE)	<i>p</i>	Coefficient (SE)	<i>p</i>
Reactivity: Intercept				
<i>Intercept</i>	2.13 (0.10) <sup>a</sup>	<.001	2.11 (0.10) <sup>a</sup>	<.001
Soc. Support	<b>-0.29 (0.12) <sup>a</sup></b>	<b>.02</b>	<b>-0.29 (0.12) <sup>a</sup></b>	<b>.01</b>
Reactivity: Magnitude Change				
<i>Intercept</i>	0.20 (0.06) <sup>a</sup>	.001	0.20 (0.06) <sup>a</sup>	.001
Soc. Support	-0.02 (0.07) <sup>a</sup>	.742	-0.10 (0.05) <sup>a</sup>	.055
Reactivity: Linear Slope				
<i>Intercept</i>	-0.01 (0.01)	.14	-0.02 (0.01)	.143
Soc. Support	-0.007 (0.01)	.645	<b>-0.03 (0.02)</b>	<b>.041</b>
Reactivity: Quadratic Curve				
<i>Intercept</i>	-0.10 (0.03)	<.001	-0.10 (0.03)	<.001
Soc. Support	-0.04 (0.03)	.238	<b>-0.07 (0.03)</b>	<b>.007</b>
Recovery: Intercept				
<i>Intercept</i>	2.26 (0.09) <sup>a</sup>	<.001	2.24 (0.09) <sup>a</sup>	<.001
Soc. Support	<b>-0.24 (0.11) <sup>a</sup></b>	<b>.037</b>	<b>-0.28 (0.10) <sup>a</sup></b>	<b>.01</b>
Recovery: Magnitude Change				
<i>Intercept</i>	-0.13 (0.05) <sup>a</sup>	.017	-0.14 (0.05) <sup>a</sup>	.019
Soc. Support	<b>-0.16 (0.07) <sup>a</sup></b>	<b>.027</b>	<b>-0.15 (0.05) <sup>a</sup></b>	<b>.007</b>
Recovery: Linear Slope				
<i>Intercept</i>	-0.05 (0.02)	.017	-0.05 (0.02)	.019
Soc. Support	0.004 (0.02)	.832	0.03 (0.03)	.321

Note: <sup>a</sup> = slopes that were set to random

Bold *p* values indicate that the growth curve patterns significantly predicted the observed psychological responses.

***Test of Social Support Model 3 (in-person social support condition vs control condition)***

**Cardiovascular Responses:** Because SBP magnitude change during reactivity and recovery was statistically significantly moderated by social support Model 1, SBP was analyzed

using the remaining two social support models. The dummy-coded variable that corresponded to the prediction of social support Model 3, which examined in-person social support compared to no social support, was tested as a moderator of the cardiovascular patterns of magnitude change, linear slope, and quadratic curve during reactivity and recovery. See Table 10 for the results of the hierarchical linear model for the cardiovascular parameter of SBP.

**Reactivity.** For the *reactivity* task period, SBP was not moderated by social support Model 3 at all. Results for reactivity magnitude change,  $t(47) = -1.36, p = .179$ , linear slope,  $t(170) = -1.13, p = .261$ , and quadratic curve,  $t(47) = -0.36, p = .719$ . These results do not support the hypothesis that participants who receive in-person social support would have lower cardiovascular reactivity during a stressor.

**Recovery.** For the *recovery* task period, SBP magnitude change was positively statistically significantly moderated by the model,  $t(266) = 2.63, p = .009$ . Which indicates that participants who received in-person social support had higher SBP during recovery compared to participants who did not receive support. The social support model did not significantly moderate linear recovery slope for SBP,  $t(266) = 0.83, p = .406$ .

**Psychological Responses:** Because SET quadratic curve during reactivity and SET magnitude change during recovery were statistically significantly moderated by social support Model 1, SET was analyzed for the remaining two social support models. The dummy-coded variable that corresponded to the prediction of social support Model 3, which examined in-person social support compared to no social support, was tested as a moderator of the SET patterns of magnitude change, linear slope, and quadratic curve during reactivity and recovery. See Table 11 for the results of the hierarchical linear model for SET for Model 3.

**Reactivity.** For the *reactivity* task period, SET was moderated by social support Model 3 for linear slope,  $t(330) = -2.05, p = .041$ , and quadratic curve,  $t(330) = -2.71, p = .007$ . These results support the hypothesis that participants who received in-person social support would have reduced psychological reactivity during a stressor compared to participants who did not receive social support. However, magnitude change,  $t(47) = -1.97, p = .055$ , was not moderated by Model 3.

**Recovery.** For the *recovery* task period, SET magnitude change was negatively statistically significantly moderated by the model,  $t(47) = -2.83, p = .007$ . Which indicates that participants who received in-person social support reported lower SET during recovery compared to participants who did not receive support. The social support model did not moderate linear slope for SET,  $t(332) = 0.99, p = .321$ .

## Discussion

This study examined whether text-messaged or in-person social support from a friend attenuated cardiovascular and psychological reactivity to a laboratory speech task. We had three predictions, Model 1 tested whether participants who received any social support (text-messages or in-person) would have lower cardiovascular and psychological reactivity to the task and have quicker recovery times. Model 2 tested whether text-messaged social support in comparison to no social support would reduce cardiovascular and psychological reactivity and decrease recovery times. Model 3 examined whether those provided in-person social support would have lower cardiovascular and psychological reactivity and a faster recovery to a stressor than participants who did not receive social support. The findings were partially consistent with the predictions.

In this study, participants who received social support (in-person and text-messaged; SS Model 1) had lower SBP reactivity to the stressor compared to participants who did not receive any social support. However, SBP during the recovery period was elevated for participants who received social support compared to participants who did not receive social support. Socially supported participants also reported less concern for social evaluative threat during both reactivity and recovery. The results comparing in-person social support to no social support were similar to the results comparing any social support to the control group. Participant provided in-person social support did not have lower SBP during reactivity, but did have higher SBP during the recovery period compared to participants who did not receive social support. Participants who received in-person social support reported lower SET during reactivity and recovery compared to participants who did not receive social support.

Overall, the effects of social support in this study support previous social support literature (Cohen, 2004; Dickerson et al., 2008; Kiecolt-Glaser, 2009; McEwen, 2000). Many past studies have used laboratory tasks but not all have asked participants to bring in a person that they have identified as their friend. In this study, 39 out of 49 participants described the person they brought as their “good friend” or closer. When social support is delivered by close same-gender friends it tends to be supportive and effective at reducing the physiological and psychological stress response (Uno, Uchino, & Smith, 2002). Christenfeld et al. (1997) found that social support from friends reduced cardiovascular responding significantly more than a social support from a stranger. Furthermore, cardiovascular responses to laboratory stressors are reliable predictors of future cardiovascular responses (Carroll et al., 2001).

In-person social support has well established benefits for both overall health and mortality (Black & Garbutt, 2002; Uchino, 2006). Chida and Steptoe's (2010) meta-analysis on the effects of stress response upon cardiovascular risk status found that greater stress reactivity and slower recovery predicted the development of future cardiovascular disease. This is important because according to the CDC (2020) one person dies every 37 seconds from cardiovascular disease in the United States, and cardiovascular disease costs approximately \$219 billion dollars a year due to healthcare costs and loss of productivity due to illness and death. Compare et al.'s (2013) literature review found that low social support increased ones risk for developing cardiovascular disease. Therefore, it is paramount that researchers examine whether social support delivered digitally has a similar ability to reduce physiological and psychological reactivity to stressors.

Of central importance to this thesis is the comparison between text-messaged social support and no social support condition. The results of this thesis suggest that text-messages were linked to attenuated cardiovascular reactivity and reduced SET during recovery. However, the text-messages did not attenuate cardiovascular responses during recovery. Nor were text-messages able to increase positive emotions or threat challenges during reactivity or recovery. To date few other studies have examined whether text-messaged or instant-messaged social support is able to attenuate cardiovascular reactivity to a stressor.

Two other studies have evaluated the physiological effects of text-messaging or digital based communication. Seltzer et al. (2012) reported that participants who received instant-messaged social support had greater cortisol compared to participants who received in-person social support. However, Seltzer et al. study had no standardization for how social support was

delivered. Since the Seltzer et al. study recorded only instant-messages there was no way to compare support quality between their three social support conditions (in-person, phone, instant-messaging). The most common phrase used by support providers in Seltzer et al.'s instant-messaging condition was "what would you like for dinner?" During laboratory stressors the most effective forms of social support are emotional support, which provides warmth and reassurance, and informational support, which provides information on how to deal with the stressor (Taylor, 2011). A question about dinner seems unlikely to offer warmth and reassurance when experiencing a stressor.

The current study improved on these limitations by standardizing the phrases participants friends were asked to use when providing social support. Caley et al., (2018) asked female undergraduate students about their social support habits, including what phrases they thought they had used and had received from friends in-person and over text-messages during a time of stress. These responses were used to form a social support phrasebook consisting of both informational and emotional social support. The current study required friends to deliver a minimum of five phrases of social support from the Caley et al.'s phrasebook over a five minute period. In addition to the standardized social support phrasebook, the social support provision period was recorded for both the in-person and text-message conditions. This allowed us to ensure that participants in both social support conditions were actually receiving social support. And indeed, a very quick preliminary analysis of the support provision period during both conditions demonstrated that participants were receiving social support from their friends.

In another study of text messaged social support, Hooker et al. (2018) standardized the social support messages used in the text-messaging condition, but reported that supportive text



messages from a male romantic partner did not reduce cardiovascular reactivity for female participants. In this study social support was delivered by male romantic partners after the participant was told they would have to deliver a speech to an evaluative audience. Participants in this study were asked to leave their phones on so that the researcher could send them text-messages. The support phrase offered by male romantic partners was always “Don’t worry, it’s just a psych study. You’ll be fine =).” Participants were not informed that their partner would be texting them, so this support was unsolicited, and there was also no validation that the participant was indeed nervous. Unsolicited social support has been shown to increase cardiovascular reactivity to a stressor due to its potential to communicate a sense of incapability in coping with the stressor (Bolger & Ameal, 2007). According to Tracy and Robins (2007) we worry about losing social status in the eyes of others and our self-representations reflect how we see ourselves based on close others, such as a romantic partner. Threats to one’s social image or standing affect psychological and physiological reactions. These threats occur as a result of perceived social evaluation (Bosch et al., 2009) and social evaluation is able to elicit SET which increases physiological reactivity (e.g. increased blood pressure; Dickerson et al., 2008). Indeed, Hooker et al. (2008) posited that it is possible that social support elicited SET for the participants and that this impeded the effects of social support in attenuating cardiovascular reactivity.

The role of text-messaged social support in attenuating psychological stress reactivity has received relatively more support in the literature. In the current study, text-messaged social support reduced participant feelings of SET during recovery. However, neither SET during reactivity, nor negative emotions or threat appraisals were attenuated by social support during reactivity or recovery. Both Teoh et al. (2015) and Guan et al. (2017) found that instant-messages

from female friends attenuated negative emotions for women taking part in a laboratory stressor. In both studies, social support was more controlled than other text-messaging studies. Guan et al. (2017) asked female participants to bring a female friend that they had known for at least 3 months to provide social support. At the start of each session Guan et al. spent 20 minutes training friends on how to provide adequate social support, and provided a set of phrases designed to provide emotional, instrumental, and informational support and to offer validation. In Teoh et al.'s (2015) study, female friends were not required to be onsite for support provision so friends were emailed instructions on how to deliver social support and were provided a list of phrases that friends were allowed to put into their own words.

### **Limitations and Future Directions**

While the results of this study are promising, there are limitations. This study used an undergraduate university sample and their friends, both of whom identified as women. These results may therefore not be generalizable to other groups. Specifically, older populations may not benefit from text-messaged social support, as they are less likely to have the expertise required to properly use cellphones, tablets, or computers. As reported by Vogels (2019), 68% of Baby Boomers (ages 55-73) and 40% of the Silent Generation (74-91) own a smartphone. Age predicts changes in amount of social support, psychological reactivity, behavioral changes (e.g. less exercise), and all of which can decrease cardiovascular functioning (Uchino et al., 1992). Additionally, cardiovascular functioning decreases as a function of age (Hossack & Bruce, 1982; Lakatta, 1993; Pendergast et al., 1993). However, socially supported older individuals experience fewer typical age-related decreases in cardiovascular functioning (Uchino et al., 1992). Therefore, future research should examine whether it is possible to increase perceived social

support for older people through text-messages and other forms of digital communication and whether text-messaged social support is able to directly attenuate cardiovascular reactivity.

This study only examined the effect of text-messaged social support on participants and friends who identified as women. Therefore, future studies should look at how men support other men: what phrases are they using to support one another digitally, are they using digital modes of social support, and does text-messaged social support reduce cardiovascular reactivity? As reported by Kudielka et al.'s (2007) review, men consistently have higher cortisol reactivity during laboratory stressors than do women. Cortisol reactivity predicts cardiovascular reactivity (Di Dalmazi et al., 2012; Whitworth et al., 2005). Kudielka et al. (2007) found that social support was more effective at attenuating men's physiological reactivity when support came from women.

Furthermore, this laboratory stress study utilized an acute stressor. It is therefore possible that text-messaged social support does not attenuate physiological or psychological reactivity to the stressors of real life. However, there is evidence that in-person social support attenuates the stress response during everyday stressors for both adolescents (DuBois et al., 1992) and adults (Holt-Lunstad & Uchino, 2015). Given that research on text-messaged social support has found similarities in effectiveness between in-person and digital social support it is reasonable to think that text-messaged social support would also help with everyday stressors. Therefore, naturalistic and real-life studies on the effectiveness of digital social support are needed.

Unfortunately, there were numerous problems with the blood pressure equipment used for this research. It is possible that the error readings hid deviations in blood pressure, such as higher or lower blood pressure readings that would change the results of the blood pressure

analyses. Additionally, there were only 49 participants total, and the smallest condition was the in-person condition which had 14 participants. It is possible such a small sample size impeded the ability to detect the expected results for SBP recovery. It is also possible that the small sample size caused the study to lack the power to detect the effects of social support on positive emotions and challenge appraisals during reactivity and recovery. Based on the results of this study, it is important that more social support studies examine whether text-messaged social support can attenuate physiological and psychological reactivity and recovery to stress.

Low friendship quality has been known to reduce the effectiveness of social support. More negative attributes in a friendship predicts lower relationship satisfaction and more hostile attributes within the relationship (Bagwell et al., 2005). Furthermore, participants who receive social support from friends about whom they have ambivalent feelings have greater cardiovascular reactivity than participants who receive social support from supportive friends (Uno et al., 2002). This study did measure friendship quality, and a next step is to examine whether friendship quality moderated the effects of social support on psychological and physiological reactivity.

Text mediated social support is a particularly important topic right now because of COVID-19. COVID-19 has shut down the majority of the United States since March 2020 due to its highly infectious nature and the lack of an effective treatment. According to the CDC, as of July 2020 there are 3.8 million cases and 140,630 deaths. The Washington State Department of Health (2020) recommends that people stay home in order to decrease the spread of COVID-19. The stay home orders implemented by many states means that many of us are prohibited from accessing our full social support network during an extremely stressful time. Based on past research we know that social support offers numerous protective health benefits (Black &

Garbutt, 2002; Cohen, 2004; Holt-Lunstad & Uchino, 2015). Therefore, we must rely upon digital means of communication to provide and receive the social support we so dearly need.

The results of this thesis combined with past text-message social support research provide support for the hypothesis that text-messaged social support is similarly effective to in-person social support in reducing the deleterious effects of stressors. Social support has also been shown to reduce risk for coronary heart disease (Holt-Lunstad & Uchino, 2015), decrease depression (Cole et al., 2017), and increase immune functioning (Baron et al., 1990). Furthermore, in Holt-Lunstad et al.'s (2010) meta-analysis found that greater social support was associated with a 50% increase in survival odds compared to people who report little available social support. In addition, people who were ill but had high social support had a greater likelihood of survival. The importance of text-messaged mediated social support for physical health is particularly salient in our current social environment because of how many of us are currently physically cut off from our social support networks due to COVID-19. Furthermore, text-messaged mediated social support needs considerably more research attention. Text messaging is now the preferred form of communication for people aged 18 to 49 years (Forgays et al., 2014). Trends of increased use of text-messages seem likely to rise, making texting a dominant means of providing and receiving social support.

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## Appendix A

### Cover Story Given after Participant has signed consent form and received baseline readings

Prior research has shown that experiencing digital and in-person interactions while studying reduces your ability to stay focused and this impacts your overall performance (Rosen, Carrier, & Cheever, 2012). Based on these results, we designed a study to test if in person or text messages from a friend during a speech preparation session will impact how distracted a person feels and if this impacts how they feel about their presentation. As such, we will be asking your friend to text message, or be with, you during the first five minutes of your speech preparation phase.

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## **Appendix B**

### Social Support Phrasebook

#### **Emotional Social Support**

1. You can do it, I believe in you
2. You can handle what life is throwing at you, whether or not you think so
3. You are a strong person
4. You are such an amazing person, you got this!
5. You have studied so hard for this and I totally believe that you can do a great job at it!
6. You are a bad bitch who can do anything
7. You're really good at bringing things together at the last minute
8. They will love you
9. You know what you're doing and the presentation will be over tomorrow
10. Let's go celebrate after your presentation
11. It's ok to be nervous because that means you want to do a good job
12. It's normal and understandable to be anxious about a presentation
13. I know that presentations are stressful sometimes, but I know that you can do this and will do really well
14. You're going to kill it!
15. I love you // I love and care about you/believe in you
16. You are an amazing, beautiful, and intelligent person
17. You are gonna kill this presentation because you're a badass and you know that

#### **Instrumental Social Support**

18. You could create small note cards with the main points.
19. Stay calm and act confident
20. Try writing an outline of what should be in your presentation
21. Once you're done with the presentation, try not to think too much about it and maybe go do something fun to destress
22. Remember to not talk too fast during your presentation
23. Think about what is worrying you most and what you can do to overcome that
24. Not everyone pays attention to the presentations in a class so you don't need to worry/be self-conscious
25. Don't forget to take a small break every once in awhile.
26. Remember to not talk too fast during the presentation

### Appendix C

#### Friendship Quality Measure

Thinking about the friend you've brought with you, please answer the following.

1. I am very committed to maintaining this friendship.

1	2	3	4	5	6
not at all true	A little true	Somewhat true	Mostly true	Almost completely true	Completely true

2. I do not feel any moral duty or obligation to continue this friendship.

1	2	3	4	5	6
not at all true	A little true	Somewhat true	Mostly true	Almost completely true	Completely true

3. I feel that I can trust my friend completely.

1	2	3	4	5	6
not at all true	A little true	Somewhat true	Mostly true	Almost completely true	Completely true

4. My friend is a thoroughly dependable person.

1	2	3	4	5	6
not at all true	A little true	Somewhat true	Mostly true	Almost completely true	Completely true

5. I am extremely happy with my friendship.

1	2	3	4	5	6
not at all true	A little true	Somewhat true	Mostly true	Almost completely true	Completely true

6. I have a very strong relationship with my friend.

1	2	3	4	5	6
not at all true	A little true	Somewhat true	Mostly true	Almost completely true	Completely true

7. I am perfectly satisfied with my friendship.

1	2	3	4	5	6
not at all true	A little true	Somewhat true	Mostly true	Almost completely true	Completely true

8. I communicate well with my friend.

1	2	3	4	5	6
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	not at all true	A little true	Somewhat true	Mostly true	Almost completely true	Completely true
9. I feel that I really understand my friend.	1	2	3	4	5	6
	not at all true	A little true	Somewhat true	Mostly true	Almost completely true	Completely true
10. I feel that my friend really understands me.	1	2	3	4	5	6
	not at all true	A little true	Somewhat true	Mostly true	Almost completely true	Completely true
11. I feel emotionally close to my friend.	1	2	3	4	5	6
	not at all true	A little true	Somewhat true	Mostly true	Almost completely true	Completely true
12. I still feel a strong connection with my friend.	1	2	3	4	5	6
	not at all true	A little true	Somewhat true	Mostly true	Almost completely true	Completely true
13. If I had my life to live over, I would still maintain a relationship with this friend.	1	2	3	4	5	6
	not at all true	A little true	Somewhat true	Mostly true	Almost completely true	Completely true
14. Our friendship is strong.	1	2	3	4	5	6
	not at all true	A little true	Somewhat true	Mostly true	Almost completely true	Completely true
15. My relationship with my friend makes me happy.	1	2	3	4	5	6
	not at all true	A little true	Somewhat true	Mostly true	Almost completely true	Completely true
16. I have a warm and comfortable relationship with my friend.	1	2	3	4	5	6
	not at all true	A little true	Somewhat true	Mostly true	Almost completely true	Completely true
17. I feel that I can confide in my friend about virtually anything.	1	2	3	4	5	6

not at all true	A little true	Somewhat true	Mostly true	Almost completely true	Completely true
18. How rewarding is your relationship with your friend?					
1	2	3	4	5	6
not at all	A little	Somewhat	Mostly	Almost completely	Completely
19. In general, how satisfied are you with your friendship?					
1	2	3	4	5	6
not at all	A little	Somewhat	Mostly	Almost completely	Completely
20. Do you enjoy your friend's company?					
1	2	3	4	5	6
not at all	A little	Somewhat	Mostly	Almost completely	Completely
21. How good is your friendship compared to most friendships?					
1	2	3	4	5	6
Worse than all others (extremely bad)					Better than all others (extremely good)
22. How often do you and your friend have fun together?					
1	2	3	4	5	6
Never	Less than once a month	Once or twice a month	Once or twice a week	Once a day	More than once a day

**Appendix D**  
Perceived Social Support

1. People sometimes look to others for championship, assistance, or other types of support. How often is each of the following kinds of support **available to you** if you need it? (Sherbourne & Stewart, 1991)

	None of the time	A little of the time	Some of the time	Most of the time	All of the time
1. Someone you can count on to listen to you when you need to talk .....	1	2	3	4	5
2. Someone to give you good advice about a crisis ....	1	2	3	4	5
3. Someone who shows you love and affection ...	1	2	3	4	5
4. Someone to have a good time with .....	1	2	3	4	5
5. Someone to give you information to help you understand a situation.....	1	2	3	4	5
6. Someone to confide in or talk about yourself or your problems.....	1	2	3	4	5
7. Someone to get together for relaxation.....	1	2	3	4	5
8. Someone whose advice you really want.....	1	2	3	4	5
9. Someone to do things with to help you get your mind of things.....	1	2	3	4	5

## Appendix E

### Social Evaluation

Thinking about the presentation you just gave, please indicate the extent to which you are feeling each of the following emotions.

1. My friend seemed to think I would do fine during this presentation.

1	2	3	4	5
Strongly disagree	Disagree	Neutral	Agree	Strongly agree

2. My friend seemed to think I had a hard time during this presentation.

1	2	3	4	5
Strongly disagree	Disagree	Neutral	Agree	Strongly agree

3. I was worried about what my friend was thinking about me during this presentation.

1	2	3	4	5
Strongly disagree	Disagree	Neutral	Agree	Strongly agree



**Appendix F**  
Discrete Emotions

Thinking about the study, please indicate the extent to which you are feeling each of the following emotions using the scale below.

- | 1                | 2 | 3 | 4 | 5 | 6 | 7         |
|------------------|---|---|---|---|---|-----------|
| Not at all       |   |   |   |   |   | Extremely |
| 1. Excited       |   |   |   |   |   |           |
| 2. Happy         |   |   |   |   |   |           |
| 3. Proud         |   |   |   |   |   |           |
| 4. Appreciative  |   |   |   |   |   |           |
| 5. Satisfied     |   |   |   |   |   |           |
| 6. Calm          |   |   |   |   |   |           |
| 7. Relaxed       |   |   |   |   |   |           |
| 8. Sleepy        |   |   |   |   |   |           |
| 9. Sad           |   |   |   |   |   |           |
| 10. Nervous      |   |   |   |   |   |           |
| 11. Afraid       |   |   |   |   |   |           |
| 12. Anxious      |   |   |   |   |   |           |
| 13. Annoyed      |   |   |   |   |   |           |
| 14. Angry        |   |   |   |   |   |           |
| 15. Embarrassed  |   |   |   |   |   |           |
| 16. Ashamed      |   |   |   |   |   |           |
| 17. Disappointed |   |   |   |   |   |           |

## Appendix G

### Threat versus Challenge Appraisal

Now please answer the following questions.

Responses range from 1 (*Not at all*) to 7 (*Very much so*)

#### Importance

1. This presentation is important to me right now

1	2	3	4	5	6	7
Not at all						Very much so

2. I care about this presentation

1	2	3	4	5	6	7
Not at all						Very much so

3. The current presentation matters very little to me

1	2	3	4	5	6	7
Not at all						Very much so

4. My grade for the current presentation is important to me.

1	2	3	4	5	6	7
Not at all						Very much so

#### Demand

5. I feel overwhelmed by the current presentation

1	2	3	4	5	6	7
Not at all						Very much so

6. The current presentation does not pose any threat for me

1	2	3	4	5	6	7
Not at all						Very much so

7. This presentation is challenging for me

1	2	3	4	5	6	7
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Not at all							Very much so
8. This presentation is stressful for me							
1	2	3	4	5	6	7	
Not at all							Very much so
Resources							
9. I know what I can do to get a good grade on this presentation.							
1	2	3	4	5	6	7	
Not at all							Very much so
10. I am able to determine a great deal of what happens in this presentation.							
1	2	3	4	5	6	7	
Not at all							Very much so
11. I know what I have to do to influence my grade on this presentation							
1	2	3	4	5	6	7	
Not at all							Very much so
12. I am able to do something to influence the course of presentation							
1	2	3	4	5	6	7	
Not at all							Very much so
14. I am capable of handling the current situation.							
1	2	3	4	5	6	7	
Not at all							Very much so
15. I have control over this presentation right now.							
1	2	3	4	5	6	7	
Not at all							Very much so
16. I can cope with the current presentation.							
1	2	3	4	5	6	7	
Not at all							Very much so

17. I have the ability to deal with the current presentation

1	2	3	4	5	6	7
Not at all						Very much so