DUAL EFFECTS OF SOCIAL SUPPORT ON CARDIOVASCULAR REACTIVITY: SOCIAL SUPPORT AS A COMFORT AND AN ENCOURAGEMENT

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Dual Effect of Social Support on Cardiovascular Reactivity: Social Support as a Comfort and an Encouragement

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The Supervisory Committee certifies that this ***disquisition*** complies with North Dakota State University's regulations and meets the accepted standards for the degree of

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ABSTRACT

The stress-buffering hypothesis (Cohen & McKay, 1984) proposes that social support attenuates cardiovascular reactivity (CVR) in times of stress. Past research which tested this hypothesis has obtained inconsistent findings. A dual effect model of social support and stress (Teoh & Hilmert, 2015) suggests that these inconsistent findings could be due to different effects of social support on CVR that depend on how engaged participants are during a stressful task. Specifically, this model proposes that when people are not engaged, social support encourages, increasing CVR relative to no support; and when people are engaged, social support comforts, attenuating CVR relative to no support. This study examined the dual effect model by empirically manipulating social support and task engagement while monitoring participants' cardiovascular readings. We randomly assigned the participants (N = 121, all women) to give a speech on either a more engaging or a less engaging topic while receiving social support or no support from two evaluative female audience members. Before and after the speech, the participants completed several questionnaires that included measures of perceived stress and task engagement. Our results showed that, consistent with our prediction, socially supported participants responded to the task with greater CVR than nonsupported participants in the less engaging condition, indicating a social encouragement effect of social support. However, when the speech topic was more engaging, there was no significant effect of social support on CVR. Our findings show that task engagement moderates the effects of social support on CVR. The health implication of a CVR-elevating effect of social support is relatively unexplored and suggests that increased CVR to stress may be associated with positive health in certain situations.

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INTRODUCTION

Overview

Social support has been robustly associated with better health (House, Landis, & Umberson, 1988). According to the stress-buffering hypothesis (Cohen & Wills, 1985), social support benefits health primarily because it buffers the negative impacts of stress. For example, social support can alleviate cardiovascular reactivity (CVR), that is, decrease blood pressure and heart rate (HR) responses to stress (Cohen & Wills, 1985). However, research documenting the effects of social support on CVR has reported inconsistent findings. In some studies social support has decreased CVR (e.g., Lepore, Allen, & Evans, 1993), whereas in other studies social support has had no effect (e.g., Craig & Deichert, 2002) and has even elevated CVR (e.g., Anthony & O'Brien, 1999) relative to a nonsupport control condition.

In addition to a CVR-decreasing or, what we are calling, a social comforting effect, there is emerging evidence that social support can have a social encouragement effect in times of stress (e.g., Cicero, Lo Coco, Gullo, & Lo Verso, 2009). Social encouragement motivates its target to act, resulting in a mobilization of cardiovascular functioning, and hence increases blood pressure and HR, to supply oxygen and energy for action (Elliott, 1969). Thus, it is our contention that during stress, when the primary effect of social support is to comfort, social support will tend to attenuate CVR; and when its primary effect is to encourage, social support will elevate CVR relative to when no social support is provided.

The purpose of this project was to explain the inconsistent social support-CVR findings in previous studies and to gain a better understanding of the psychophysiological effects of social support during stress. We predicted that social support would increase and decrease CVR depending on task engagement. As such, this project examined the effect of social support on

CVR in stressful laboratory settings that were designed to elicit a high or low level of task engagement. It was hypothesized that when participants are engaged in a stressful situation, social support would comfort the recipients and decrease CVR relative to no support. In contrast, when participants are not engaged in the stressful situation, perhaps because the situation is overwhelming or not very stressful to the participants (Lazarus & Folkman, 1984), social support would encourage the recipients to engage and elevate CVR relative to no support.

Social Support

Social support refers to behaviors occurring during interpersonal transaction of messages that make its recipients feel cared for, esteemed, and loved (Cobb, 1976). Social support is provided and received among social contacts of varying strengths of connection. It may serve to give advice, assist with problems, provide information, share personal concerns, and, when appropriate, comfort and encourage (Cohen & Wills, 1985).

A bulk of past studies has documented many benefits of social support. People who report feeling more supported tend to be more engaged in healthy behaviors, such as eating nutritious food, being more physically active, controlling or reducing stress in effective ways, and being responsible for their own well-being (Webb, Hirsch, & Visser, 2013). Social support also increases adherence to medical regimens and decreases suicidal acts (Tay, Tan, Diener, & Gonzalez, 2013).

In terms of physical health, research has linked social support to a variety of positive outcomes, including lower risk of developing cardiovascular disease (CVD; Rosengren, Wilhelmsen, & Orth-Gomer, 2004). The benefits of social support also extend to people who have already developed disease. Social support slows down the progression of CVD (Lett et al., 2005), speeds up recovery from a cardiovascular event (Vogt, Mullooly, Ernest, Pope, & Hollis,

1992), lowers the likelihood of recurrent events (Horsten, Mittleman, Wamala, Schenck-Gustafsson, & Orth-Gomer, 2000), and decreases disease-related mortality (Barefoot, Gronbaek, Jensen, Schnohr, & Prescott, 2005).

In a five-year longitudinal study using middle-aged Swedish women who were hospitalized for heart problems, Horsten and colleagues (2000) noted that women who were more socially integrated were less likely to experience recurrent cardiac events and had a higher event-free survival probability. A relatively recent meta-analysis reported that across numerous studies stronger social relationships predicted lower mortality and higher odds of survival (Holt-Lunstad, Smith, & Layton, 2010), including lower mortality linked to myocardial infarction and coronary heart disease (Everson-Rose & Lewis, 2005).

Researchers have proposed models to explain how social support benefits health. The most influential models have been the stress-buffering hypothesis and the direct effect hypothesis of social support (Cohen & Wills, 1985). Despite an important dissimilarity in these models regarding the impact of social support on health during nonstressful times, both models highlight the positive impacts of social support in times of stress, which is the focus of this project.

Social support during stress: The social comforting effect. The stress-buffering hypothesis (Cohen & Wills, 1985) suggests that social support benefits our well-being mainly by interfering with the impacts of stress on health. For instance, social support can comfort its stressed recipients and hence alleviate increases in blood pressure and HR that occur in response to stress, mitigating the result of long and hard use on the cardiovascular system (McEwen, 1998) and lowering one's risk for CVD.

Mainly inspired by the stress-buffering hypothesis (Cohen & Wills, 1985), many past studies have investigated how social support affects CVR in times of stress. These studies

typically induced stress in a laboratory setting and manipulated social support. Many laboratory studies designed to test the stress-buffering effects of social support have been supportive of this model (Uchino, Cacioppo, & Kiecolt-Glaser, 1996). However, findings from these studies have not always supported the stress-buffering hypothesis (e.g., Anthony & O'Brien, 1999; Craig & Deichert, 2002), suggesting that, in some situations social support might have an effect other than comfort and the mitigation of CVR. In fact, there is evidence that in times of stress social support may not influence CVR, or it may even increase it (Teoh & Hilmert, 2015).

Social support during stress: The social encouragement effect. In the behavioral literature, it is known that social support not only comforts people during stress, it also provides encouragement, possibly motivating recipients to act or to deal with the stressor (Wills, 1985). There is accumulating evidence highlighting the healthful social encouragement effect of social support. For instance, a study by Cicero and colleagues (2009) documented that cancer patients who received social support from friends felt motivated and viewed the disease as a challenge rather than a threat, increasing the likelihood they would participate actively in therapy and have less passive acceptance of the illness. The social encouragement effect of social support seems to benefit health by motivating people to act constructively in times of stress (and possibly in times without stress), such as to use an effective coping strategy and avoid unhealthy and ineffective coping strategies like smoking, drinking, and avoidance. Different from the social comforting effect which mitigates CVR, social encouragement motivates action. Therefore, it makes sense that in these situations a mobilization of energy in the form of the delivery of oxygen and nutrients throughout the body is necessary. Thus, when encouraging, social support should raise blood pressure and HR (Brehm & Self, 1989).

Social Support and Task Engagement

A dual social comforting and social encouragement model of social support (see Figure 1) may help explain the inconsistent findings in the existing literature. That is, some studies might have created a context which facilitated a social comforting effect, and some studies might have unintentionally created a context which facilitated a social encouragement effect on CVR. If this is the case, it is important to know what factor(s) moderates the effect of social support in this way, essentially reversing its effect on CVR.

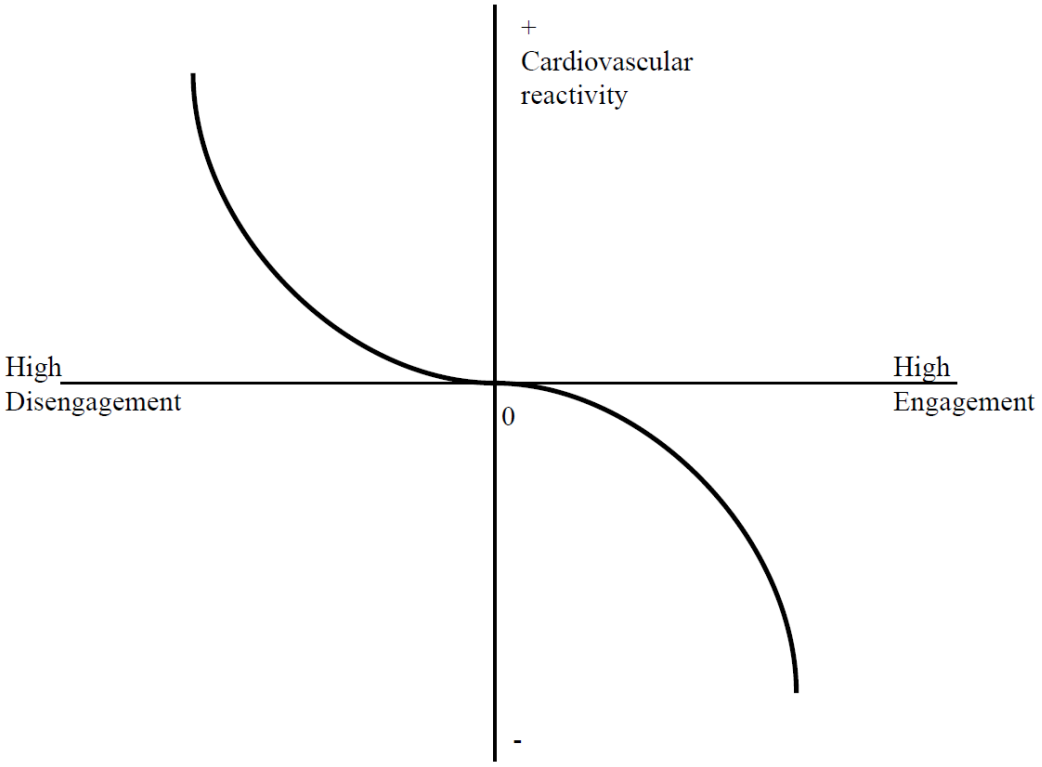

Figure 1. The dual effect model of the effect of social support (Teoh & Hilmert, 2015) on cardiovascular reactivity (CVR) as task engagement varies. The curve in the lower, left quadrant suggests that when people are more engaged in a task social support decreases CVR, whereas the curve in the upper, left quadrant suggests that when people are less engaged in a task social support elevates CVR. On the other hand, when a participant is only moderately engaged or disengaged (toward the midpoint of the engagement dimension) social support has minimal or null effect on CVR. Adapted from Teoh and Hilmert (2015).

An early line of research suggested that the stress-CVR association varied as a function of motivation to put forth effort (active coping) during an experimental stress task (Elliott, 1969; Obrist, 1976; Wright & Kirby, 2001). For example, Elliott (1969; Experiment 2) examined the stress-CVR association by manipulating stress task difficulty. The participants in the experiment judged whether presented tones matched a target tone in 70 trials. The target and judged tones differed in their frequency, with the largest differences in frequency comprising an easy task, moderately small differences comprising a moderately difficult task, and the smallest differences a very difficult task. The participants performing the moderately difficult task showed a significant increase in HR, whereas those performing the easy or very difficult task had unchanged HR. Self-reported motivation explained the differences in HR responses to tasks of varying difficulty levels, in which most of the participants reported a decrease in motivation when performing the easy and very difficult tasks (Elliott, 1969).

Social support may work differently in situations that induce different levels of task engagement. Hilmert, Kulik, and Christenfeld (2002) showed that social support had opposing effects on CVR in modestly varied social situations. Participants in this experiment performed a speech task during which they received either supportive feedback (social support) or nonsupportive feedback (no social support) from an audience. During the speech, a male experimenter wearing a white coat was either present or absent. Results showed that, in the presence of the experimenter, the participants who received social support had lower CVR than those who did not receive support. In contrast, in the absence of the experimenter, the participants who received social support showed greater CVR than those who did not.

Hilmert, Kulik, and colleague (2002) speculated that the opposing cardiovascular effects of social support were associated with participants' task engagement, and that task engagement

was influenced by the evaluation apprehension created by the presence of an authority figure, the experimenter. When the experimenter was present, social support from the audience member presumably assuaged the participants' concern and hence decreased their CVR. On the other hand, in the absence of the experimenter, the participants were less concerned about being evaluated, and they were less engaged in the stressful public speaking task. Social support from the audience in this situation might encourage participants to feel more competent and to be more engaged in the task.

No CVR studies have explicitly considered the moderating effect of task engagement on social support. Many studies have investigated how certain personality or environmental factors moderate the effect of social support on CVR, and a number of these moderators may have been associated with task engagement. Teoh and Hilmert (2015) reviewed the social support-CVR literature. Using the reported CVR findings and relevant research, they categorized a variety of moderator conditions as either less engaging or more engaging in as many of these studies as possible. For example, in the study by Hilmert, Christenfeld, and Kulik (2002) which examined the moderating effect of self-efficacy on a social support-CVR association, participants with high self-efficacy for public speaking were considered more engaged in a speech task than those with low self-efficacy based on greater CVR and previous literature concerning self-efficacy and task engagement. Teoh and Hilmert then performed a series of meta-analyses to test the hypothesis that social support would decrease CVR in more engaging situations and increase CVR in less engaging situations. These meta-analyses showed that, relative to a nonsupport condition, when situations were more engaging, social support alleviated blood pressure responses to stress. However, when situations were less engaging, social support had no significant effects on blood pressure and HR responses (Teoh & Hilmert, 2015). This provided evidence that task

engagement does moderate the effect of social support on CVR. However, the analyses fell short of showing that social support would increase CVR in low engagement situations.

Teoh and Hilmert (2015) suggested that the null effect of social support on CVR observed in the less engaging group could be due to a social comforting bias in the literature. That is, the majority of the studies reviewed aimed to test whether social support had a social comforting effect on CVR during active coping (high engagement) tasks. Therefore, very few studies involved a stress condition in which participants were not engaged (perhaps, disengaged).

The purpose of this study, therefore, was to experimentally manipulate task engagement, creating a situation that engaged participants and a situation that did not engage participants. Thus, the most significant innovation in the study was the manipulation of task engagement. In the section below, we discuss the construct of task engagement and describe the rationale of the task engagement manipulation in this study.

Task Engagement

Past literature has documented characteristics of task engagement, including the involvement enthusiasm and motivation when performing the task. A high engagement situation is where people view a task as challenging, but not beyond their capabilities to handle (Elliott, 1969), and hence are enthusiastic and intrinsically motivated by the interest or enjoyment felt to complete the task (Scanlan, Carpenter, Schmidt, Simons, & Keeler, 1993). Because of this, a person devotes a high amount of effort in order to achieve a desirable outcome (Brehm & Self, 1989), receive positive judgments from others, and/or obtain a sense of perceived competence (Elliot & Harackiewicz, 1996). To facilitate these engaged, effortful actions, our physiological arousal increases (Elliott, 1969) to provide more energy for these attempts.

A low engagement situation, on the other hand, is where one perceives a task to be either excessively easy or excessively difficult with demands that are beyond one's capabilities (Elliott, 1969). People can meet an easy challenge without much effort. They cannot overcome a highly difficult challenge and are likely to withdraw from the task or to passively endure or ignore the task and its consequences. In both easy and highly difficult situations, people are less enthusiastic and not motivated, they are unwilling to invest effort into the task (Brehm & Self, 1989). Low task engagement induces only a low level of physiological arousal because little effort or energy is required to achieve one's goals (Brehm & Self, 1989). Thus, manipulating task engagement in a laboratory setting depends largely on controlling these characteristics of the stressor task.

The stressor task used in this study was a stressful speech task (see the Method section for more detail). Research has shown that this task reliably increases physiological arousal and feelings of stress (Al'Absi et al., 1997). This is a common task used in laboratory stress reactivity studies and in past social support, CVR studies. To manipulate task engagement in this task, we tailored the task to each participant, such that half of the participants were in personalized highly engaging situations and half in personalized less engaging situations.

Specifically, this study induced high and low levels of task engagement via different speech topics rated on engagement indexes by each participant. Our rationale was that a topic that is rated as challenging and within a participant's capabilities to handle would be more engaging to that participant than a topic deemed by the participant as too difficult and beyond the participant's own capabilities. Because topic knowledge and experience with topics vary, tailoring a speech topic for each individual was necessary to effectively manipulate task engagement.

Aim and Hypothesis

The purpose of this study was to manipulate task engagement in a laboratory setting, creating a more engaging and a less engaging social situation, and to test a hypothesized task engagement moderating effect on the association between social support and cardiovascular responses to stress. This study randomly assigned participants to a high engagement or a low engagement condition while they either received social support or did not receive support from an audience of two people.

We hypothesized that:

Hypothesis 1: In the low engagement condition, the participants who received social support would have greater blood pressure and HR responses to stress than those who received no support. In the high engagement condition, the participants who received social support would demonstrate lower blood pressure and HR responses than those who received no support.

In addition, we hypothesized that self-reported motivation and effort would explain the variability in CVR in association with the interaction effect between social support and task engagement. In other words, motivation and effort would mediate the interaction between social support and task engagement on blood pressure and HR responses (a mediated moderation effect). Therefore, we predicted that:

Hypothesis 2: In the low engagement condition, social support would increase blood pressure and HR responses to stress, and this effect would be explained by higher motivation and effort. That is, in the low engagement condition, relative to no support, social support would be associated with higher levels of motivation and effort, which in turn would be associated with higher blood pressure and HR responses. In the high

engagement condition, social support would be associated with lower blood pressure and HR responses to stress relative to no support, and this CVR-attenuation effect would not be explained by motivation and effort. That is, in the high engagement condition, social support would not be associated with motivation and effort, and motivation and effort would increase blood pressure and HR responses.

METHOD

Pilot Study

Before the primary study, we conducted a pilot study to shortlist 3 speech topics that are generally considered engaging and 3 that are generally considered less engaging by female undergraduates. To do this, we had 252 female participants, aged 18 to 29 years old (M = 18.96, SD = 1.54), recruited through the North Dakota State University (NDSU) SONA system, an online participant pool management software. They completed an online survey by rating 30 speech topics on a four-item speech task engagement scale we developed. See Appendix A for the consent form.

The self-developed task engagement scale (Appendix B) measured how engaged participants would be to give a speech on each of the 30 speech topics listed (e.g., "Why an employer should hire you", "Islam and terrorism") on a nine-point Likert scale ranging from 1 (*not at all*) to 9 (*very much*). The scale asked how *confident* and *interested* the participant would be, how *difficult* it would be, and how much *effort* they would put forth to give a speech on each topic. These items represent the three components of task engagement construct mentioned earlier, including perceived challenge, capability, and effort. Specifically, the items *confident* and *difficult* were related to the level of perceived challenge and participants' capabilities to handle the task. The *interested* item targeted intrinsic motivation, and the *effort* item measured participants' enthusiasm and effort. The ratings for the four items were reverse scored where appropriate. See Table 1 for the speech topics and their scores on each item.

Table 1

The Speech Topics and Their Scores on Each Task Engagement Item during the Pilot Study

Topics	Difficulty	Confidence	Effort	Interesting
* ABORTION	5.18	5.45	6.75	4.58
ADOPTION BY GAY AND LESBIAN FAMILIES	5.07	5.16	6.19	4.57
* ANIMALS HAVE EMOTIONS	4.50	5.55	6.33	4.32
BARACK OBAMA	5.81	4.35	5.19	6.16
BEST PLACES TO EAT AND DRINK IN FARGO	4.01	5.86	6.10	4.29
BINGE DRINKING ON COLLEGE CAMPUSES	4.79	5.30	5.89	4.98
* BIRTH CONTROL	4.09	5.98	6.29	4.57
EUTHANASIA	6.29	4.18	6.08	5.00
EVOLUTION AND RELIGION	5.55	4.69	5.76	5.30
FAIRNESS OF ASSESSMENT IN NDSU CLASSES	5.12	4.88	5.81	5.37
HOMOSEXUALS IN THE U.S. MILITARY	5.86	4.25	5.63	5.26
HOW TO CHOOSE A WINE	6.24	3.69	5.19	5.83
# ISLAM AND TERRORISM	6.92	3.19	4.94	6.44
# LEGALIZING PROSTITUTION	7.04	2.94	4.21	7.07
ONLINE COURSES VERSUS ON-CAMPUS COURSES	4.53	5.47	5.64	5.24
# PORNOGRAPHY	7.20	2.73	4.09	7.49
RELIGION AND MORALITY	5.43	4.71	5.72	5.43
SEXUALLY TRANSMITTED INFECTIONS	5.67	4.33	5.52	6.02
SHOULD NDSU INCREASE STUDENT FEES	4.59	5.55	6.54	4.62
SHOULD NDSU PROVIDE MORE PARKING FOR STUDENTS?	3.65	6.33	6.46	4.06
TEACHING CREATIONISM IN PUBLIC SCHOOLS	5.60	4.52	5.69	5.75
THE EXISTENCE OF ALIENS	6.48	3.44	4.53	6.46
THE GREEK (FRATERNITY/SORORITY) SYSTEM	6.02	4.06	4.86	6.33
THE NDSU FOOTBALL TEAM	4.70	5.38	5.93	4.72
THE U.S. SHOULD CUT OFF ALL FOREIGN AID TO DICTATORSHIPS	6.99	3.14	5.20	6.42
WHAT YOU DISLIKE ABOUT YOURSELF	6.03	4.33	5.05	6.73
WHAT YOU LIKE ABOUT YOURSELF	5.19	5.14	5.66	5.75
WHY AN EMPLOYER SHOULD HIRE YOU	4.12	6.21	7.00	4.38
WHY YOU ARE A GOOD FRIEND	3.80	6.45	6.16	4.82
YOUR FAVORITE FOOD	2.35	7.52	5.98	4.35

Note. * denotes speech topics selected as more engaging topics, # denotes speech topics selected as less engaging topics. The scores of the *Effort* item were reverse scored. Higher scores indicate higher levels of difficulty, confidence, effort, and interestingness.

Based on the ratings, we selected three topics rated as more engaging ("Animals have emotions," "Why an employer should hire you," and "Birth control"), that is higher scores on *confident*, *effort,* and *interested,* and moderately high on *difficulty*. We also chose three topics rated as less engaging ("Islam and terrorism," "Legalizing prostitution," and "Pornography"), that is lower scores on *confident*, *effort,* and *interested,* and high on *difficulty*. These six topics were representative of the topics which would likely be engaging or not be engaging for female college students.

Primary Study

In the primary study participants ranked the six pre-tested topics and then gave a speech on either their most engaging or least engaging topic to an audience that was either supportive or nonsupportive.

Participants and design. Participants (N = 121), aged between 18 and 30 years old (M = 19.08, SD = 1.66), were recruited from NDSU via NDSU SONA system. This study invited only women for participation to avoid the effects of gender on social support-related outcomes (Glynn, Christenfeld, & Gerin, 1999). Research has documented gender differences in response to social support, whereby women tended to benefit more from emotional support (supportive feedback and gestures; Nagurney, Bagwell, & Forrest, 2009), and men benefitted more from instrumental support (direct assistance with the task at hand; Wilson et al., 1999). As we focused on emotional support in the present study (see the "Social Support Manipulation" subsection for more detail), male participants might be less responsive to the social support manipulation than female participants. Table 2 shows the demographic characteristics of the participants.

Table 2

Demographic Characteristics of the Study Participants

Demographic variable	Categories / Descriptive Statistics	Social support - low engagement (n = 29)	Social support - high engagement (n = 32)	No support - low engagement (n = 30)	No support - high engagement (n = 30)
Ethnicity	American Indian/Alaskan Native	1	0	0	1
	Asian	0	2	2	2
	Black or African American	3	1	1	3
	Hispanic/Latino	2	0	2	2
	White/Caucasian	22	27	24	22
	Mixed	1	2	0	0
	Unidentified	0	0	1	0
Age (years)	*M*	19.14	18.94	19.24	19.03
	SD	1.73	1.29	2.31	1.19
Height (cm)	*M*	165.03	167.47	168.07	165.20
	SD	6.90	6.99	7.52	6.96
Weight (kg)	*M*	66.28	64.06	68.69	65.13
	SD	11.53	8.86	11.78	9.07
BMI	*M*	24.33	22.80	24.32	23.91
	SD	3.91	2.52	3.83	3.31
Baseline SBP (mmHg)	*M*	122.95	116.73	119.25	117.58
	SD	10.47	7.68	13.43	9.80
Baseline DBP (mmHg)	*M*	76.96	71.49	74.16	72.59
	SD	10.48	8.09	9.02	8.44
Baseline MBP (mmHg)	*M*	95.47	89.62	92.21	90.50
	SD	10.38	7.34	10.00	8.70
Baseline HR (beat per minute)	*M*	78.90	78.86	80.59	77.02
	SD	8.56	11.41	12.72	9.86

Note. *M* = mean; *SD* = standard deviation; BMI = body mass index; SBP = systolic blood pressure; DBP = diastolic blood pressure; MBP = mean blood pressure; HR = heart rate.

This study used a 2 (social support condition: social support, no support) by 2 (task engagement condition: high engagement, low engagement) between-subject factorial design. We randomly assigned the participants to receive either social support or no social support in a high engagement or a low engagement condition. The dependent variables (DVs) were changes in cardiovascular functioning from a resting baseline to a stressful task period. The cardiovascular indices observed in this study included systolic blood pressure (SBP; the arterial pressure when the ventricles of the heart contract), diastolic blood pressure (DBP; the arterial pressure when the ventricles of the heart dilate), mean blood pressure (MBP; the average blood pressure measured during a cardiac cycle), and HR (the number of times the heart beats in a minute).

There were about 30 participants in each cell of the factorial design (see Table 2). This cell size provided sufficient power for analyses for two reasons. First, the past studies of a similar nature have had at least 12 to 20 participants per condition (e.g., Van Well & Kolk, 2008). Second, analysis of variance (ANOVA), the analysis method used here for hypothesis testing, is generally robust to violation of the normality assumption with relatively equal cell sizes and at least 20 degrees of freedom for the error term (Tabachnick & Fidell, 2007). A sample size of 30 participants in each cell provided more than 20 degrees of freedom for the error term.

We excluded participants with a family history of CVD and who were hypertensive or using medication that affects cardiovascular or neuroendocrine functioning. The NDSU Institutional Review Board approved all materials and procedure.

Physiological and psychological measures.

Physiological measures. We took beat-to-beat measures of blood pressure and HR with a Finometer (Finapres Medical Systems). The Finometer provides a continuous measure of

cardiovascular activity using the volume-clamp method (Peñáz, 1973) by means of a finger cuff on the middle finger of a participant's nondominant hand.

Pretask scale. The pretask scale (Appendix C) required the participants to rank the six speech topics shortlisted through the pilot study in terms of the participants' feelings of how *easy it would be*, how *interested* and *confident* she would be, and how much *effort* she would put forth to give a speech on each topic respectively. The participants rank ordered the topics so that 1 represented the least ease, interest, confidence, or effort, and 6 the most. To prevent the participants from anticipating that they would perform a speech task, we added one filler item which asked the participants to rank the *comfort* level they would feel if they were to perform mental arithmetic tasks on six mental arithmetic questions listed. We randomized across participants the sequences of the speech topics and the ranking items. We summed up the rankings on the four items given to each topic so that higher scores indicated more engagement. The participants completed this scale between the first resting baseline period and the stressor task period.

Perceived social support scale. We developed a perceived social support scale (Appendix D) to be administered following the stressor task. This scale used 11 items to assess the perceived level of social support. Two items measured how *supported* participants felt during the task (O'Donovan & Hughes, 2008) and how *satisfied* they were with the social support received (Hughes & Curtis, 2000). In addition to these, we included nine items that measured other aspects of social support. Three of these items measured how *acknowledged, comforted,* and *confident* participants felt during the task. The remaining items assessed the extent to which the audience members were *helpful* and *motivating,* made participants feel more *nervous, relieved* participants' nervousness, gave *suggestions,* and made the participants *try harder*. The

participants rated these items on a five-point Likert scale ranging from 1 (*not at all*) to 5 (*very much*). The Cronbach's alpha of this scale was .91. We reverse scored appropriate items and averaged the ratings so that a higher score indicated a higher level of perceived social support.

Stress/arousal adjective checklist. The participants completed the 20-item Stress/Arousal Adjective Checklist (SACL; King, Burrows, & Stanley, 1983; Appendix E) before and after the stressor task. This scale comprises two orthogonal 10-item subscales, which measured stress and arousal respectively (King et al., 1983). The stress subscale measures people's responses to coping with a threat, and the arousal subscale measures how people respond to perceived demand in coping with a threat. Previous studies have documented the validity of SACL in differentiating stress and arousal levels in normal populations, psychiatric patients, and military personnel (King et al., 1983; McCormick, Walkey, & Taylor, 1985). Our participants responded to each of the 20 adjectives, such as "tense," "uneasy," and "worried," in terms of how much they felt the emotion at the moment. They rated their responses on a four-point Likert scale ranging from 0 (*definitely no*) to 3 (*definitely yes*). We averaged the responses to the items comprising the stress and arousal subscales at each time point respectively, with higher scores indicating higher levels of stress and arousal. The internal consistency of SACL was high in this study, with values of .85 and .93 for the stress subscale before and after the task, respectively, and about .81 for the arousal subscale before and after the stressor task.

The intrinsic motivation inventory. The participants completed this scale (Appendix F) after the task, indicating how motivated they felt during the speech task using a seven-point Likert scale from 1 (*not at all*) to 7 (*very strongly so*). This scale (McAuley, Duncan, & Tammen, 1989) comprises 18 items that measure intrinsic motivation in four subscales, namely interest/enjoyment (5 items), perceived competence (5 items), effort/importance (4 items), and

pressure/tension subscales (4 items). We adapted the scale from a competitive sport setting to a speech task setting. For instance, we changed the item "I enjoyed this basketball game very much" to "I enjoyed doing the task very much." Other examples of the modified items include "I could do the task very well" and "I would describe the task as very interesting." A past study (McAuley et al., 1989) that tested the validity of this scale confirmed the four-factor structure. In the present study, the four subscales had high internal consistency with Cronbach's alpha values ranging from .74 to .89. The scores of the respective items of each subscale were averaged with higher scores denoting a higher level of intrinsic motivation.

Utrecht work engagement scale. We administered the Utrecht Work Engagement Scale (Schaufeli, Salanova, Gonzalez-Roma, & Bakker, 2002; Appendix G) after the stressor task. This scale measures in three subscales the extent to which people engage in a task. These subscales are vigor (6 items), which denotes willingness to put forth effort and a large amount of energy into a task, dedication (5 items), which refers to identification with and a sense of enthusiasm for a task, and absorption (6 items), which represents being concentrated and engrossed in a task. We adapted the student version of the scale to accommodate a laboratory setting. For instance, we modified "When I'm doing my work as a student, I feel bursting with energy" to "When I was preparing for the speech and giving the speech, I felt bursting with energy." Other modified items included "During the speech task, I was very resilient, mentally" and "The speech task inspired me." The participants indicated on a five-point Likert scale from 1 (*strongly disagree*) to 5 (*strongly agree*) how they felt during the stressor task. Schaufeli and colleagues documented the structure and divergent validity of the scale. The Cronbach's alphas of the three subscales were between .59 and .82 in this study. We averaged the responses given to the respective items of each subscale. Higher scores showed a higher level of task engagement.

Health questionnaire and demographic questionnaire. We administered both questionnaires (Appendix H) after the stressor task. The health questionnaire assesses participants' eating behaviors, exercise habits, medical conditions, and other health behaviors, such as smoking. These variables would be controlled for in the main analyses if they had significant associations with the DVs. The demographic questionnaire measures participants' education background (e.g., the year in school), race, and relationship status.

Stressor task. To induce stress, all participants performed an impromptu public speaking task. We chose this task because it is a stressor task that reliably elicits a stress response (Al'Absi et al., 1997), and it is commonly used in previous social support studies (e.g., Hilmert, Kulik et al., 2002). This task was effective in inducing perceived stress, as indicated by heightened physiological arousal and negative emotions (Al'Absi et al., 1997). During the experiment, a male experimenter informed the participant that the main task they would perform was to give a public speech in front of two trained audience members and a video camera, and that the video recording would be sent to experts in public speaking at a later time for evaluation. The experimenter emphasized that this task assessed verbal intelligence and psychological and social capabilities. The experimenter then presented a "lucky draw" box and instructed the participant to draw a card to determine her speech topic. Following this, the experimenter left the participant alone in the experiment room for 5 minutes for the participant to prepare for the speech without pen and paper.

Five minutes later, the experimenter entered the experiment room with two female audience members, who then sat facing the participant. As the participant started giving the speech for 5 minutes, the experimenter appeared to be taking notes and gave some comments in an unfriendly tone, such as "Keep eye contact with the audience" and "You have to keep talking

for 5 minutes." The audience members either gave social support or gave no support depending on the assigned social support condition.

Task engagement manipulation. We manipulated task engagement by assigning the participants to give a speech on a topic that they ranked as most engaging or least engaging. The participants completed the pretask scale before a speech task by ranking the six speech topics shortlisted through the pilot study in terms of task engagement. The experimenter then summed up the ranks given to each of the six topics. Higher summed scores indicated greater predicted task engagement for the topic. Based on these summed scores, the experimenter assigned the participants in the high engagement condition to a speech topic that had the highest summed score, and those in the low engagement condition a topic with the lowest score.

To avoid demand characteristics that might be created by assigning speech topics, we gave the participant an impression that the topic was determined randomly. The experimenter presented a box with six cards in it. He informed the participant that each card had a different topic printed on it, and that the speech topic printed on the card she chose would be her speech topic. Unknown to the participant, all cards had the same speech topic printed on them, determined by the assigned condition and pretask topic rankings.

Social support manipulation. Social support was manipulated by two female audience members who were undergraduate research assistants in the laboratory. These audience members provided either social support or no support when the participant was giving a speech. Both audience members were women in order to avoid the effect of support provider's gender on CVR (Glynn et al., 1999).

The social support manipulation method was based on manipulations used in past studies (e.g., Hilmert, Christenfeld et al., 2002). The audience members appeared as evaluative authority

figures wearing white coats. They were introduced to the participant as laboratory personnel well-trained in evaluating public speaking. The audience members sat side by side opposite the participant and held clipboards and pens, appearing to take notes during the speech. At 30 seconds into the speech, in the social support condition, the audience members nodded, leaned forward, smiled at the participant, appeared attentive, and gave supportive comments in a warm tone, such as "You're doing well!" In the no support condition, the audience members leaned back, looked bored, limited their eye contact with the participant, and appeared evaluative but also inattentive.

Procedure. Upon NDSU Institutional Review Board approval, we recruited participants through NDSU SONA system. All participants were advised to refrain from caffeine consumption, cigarette smoking, extreme exercise, and full meal at least 4 hours prior to the experiment. This was to prevent effects these behaviors could have on cardiovascular function.

During the experiment, the experimenter obtained informed consent (Appendix I) from the participant and then fitted her with blood pressure cuffs on the upper-arm and middle finger of her nondominant hand. The experimenter then asked the participant to just relax and keep her arm as still as possible during a 10-minute resting baseline period. Following the resting baseline period, the experimenter returned, and the participant completed the pretask scale.

Upon completion, the experimenter told the participant to complete the SACL questionnaire (King et al., 1983), which assessed baseline perceived level of stress. At this time the experimenter went into a preparation room to compute the scores of the pretask scale and prepare the "lucky draw" box, in which he placed the appropriate speech topic cards facing down. The experimenter then re-entered the experiment room and gave the instructions for the speech task. Upon instruction, the participant drew a card from the "lucky draw" box and

received her speech topic. The experimenter then left the room for 5 minutes during which the participant prepared for the speech. To enhance the stressfulness of the task, preparation was done without pen and paper. Five minutes later, the experimenter returned with two audience members who then sat facing the participant. After introducing the audience members as trained evaluators, giving instructions to make sure she continues speaking for the entire 5 minutes, and setting up the video camera, the experimenter told the participant to begin her speech. The audience members responded according to the assigned social support condition.

After the five-minute speech, the audience members left the room, and the participant filled out the perceived social support scale, SACL questionnaire (King et al., 1983), Utrecht Work Engagement Scale (Schaufeli et al., 2002), and intrinsic motivation inventory (McAuley et al., 1989). Following this, the participant went through an eight-minute resting baseline period and completed the health and demographic questionnaires before she was debriefed. Each experiment session took approximately 90 minutes. See Appendix J for the experiment protocol.

Data analysis strategies. We computed baseline cardiovascular readings for each cardiovascular index by averaging the readings from the last 4 minutes of the first resting baseline period. This allowed the participant to acclimate to the environment in the first 6 minutes of the 10-minute period, during which cardiovascular functions had presumably reached the basal level. Similarly, we computed the cardiovascular readings during the speech task by averaging the readings of the last 4 minutes of the 5-minute speech task for each cardiovascular parameter. This was to obtain participants' responses to the speech task and audience members' supportive or nonsupportive gestures, which began approximately 30 seconds into the speech. Next, we computed reactivity scores for each cardiovascular measure by subtracting the

averaged baseline readings from the averaged task readings. We also computed the composite scores of each psychological scale or subscale by averaging the scores of the respective items.

Before testing the hypotheses, we conducted preliminary analyses to examine how social support, task engagement, and their interaction affected baseline cardiovascular readings and other demographic readings. Also, we examined the associations among the baseline cardiovascular readings, health behaviors (e.g., eating behavior), and CVR readings. The baseline readings and health behaviors that were significantly related to their corresponding CVR reading would be included as covariates in analyses which involve that CVR reading.

Preliminary analyses also examined the efficacy of stress, task engagement, and social support manipulations. To check if feelings of stress were affected by the speech task, we compared the SACL (King et al., 1983) perceived stress and perceived arousal scores reported and cardiovascular readings observed during the 10-minute resting baseline with those during the speech task among the nonsupported participants using dependent-sample *t*-tests. We predicted that the perceived stress and arousal scores and cardiovascular readings would be significantly lower during the baseline than during the task. To check the manipulation of task engagement, we compared self-reported task engagement scores of the nonsupported participants in the high task engagement versus low task engagement conditions using a one-way between-subject ANOVA. It was predicted that an efficacious manipulation of task engagement would induce a higher level of perceived task engagement in the high engagement condition than in the low engagement condition. The manipulation checks for stress and task engagement focused only on the nonsupported participants to rule out the effect of social support on these study outcomes. To check the social support manipulation, we compared the two social support conditions in terms of perceived social support using a one-way between-subject ANOVA. An efficacious

manipulation of social support would be indicated by a higher level of perceived social support reported by the socially supported participants than the nonsupport participants.

Following the preliminary analyses, we examined the assumptions of between-subject ANOVA, a statistical analysis we used for hypothesis testing. These included the assumptions of absence of outliers and homogeneity of variance. Next, we tested the study hypothesis 1 by performing a series of two-way between-subject ANOVAs with social support condition and task engagement condition as independent variables and CVR scores of each cardiovascular parameter respectively as the DV. We performed simple effect analyses when there was a significant interaction.

We also performed mediated moderation analyses to examine the hypothesized mediating effects of motivation and effort in the interaction between social support and task engagement on CVR. We conducted these mediated moderation analyses with PROCESS (Hayes, 2013) using SPSS MACRO. We entered the social support condition as the predictor, the task engagement condition as the moderator, intrinsic motivation and effort scores as the mediating variables, and the respective CVR index as the outcome variable. A mediated moderation effect is produced when the following conditions are fulfilled (Muller, Judd, & Yzerbyt, 2005): 1) the predictor by moderator interaction effect significantly predicts the mediating variable (*a* coefficient); 2) the mediating variable significantly predicts the outcome (*b* coefficient); 3) the predictor by moderator interaction effect significantly predicts the outcome (*c* coefficient; total effect); 4) the predictability of the interaction effect on the outcome after controlling for the mediating variable (*c'* coefficient; direct effect) is greatly reduced, as compared to the total effect. The discrepancy between the total effect and the direct effect (i.e., $c - c'$) represents an indirect effect, whose coefficient is the product of *a* and *b* coefficients (*ab* coefficient; $ab = c - c'$). In other words, the

fourth condition tested with PROCESS using a 5000 bootstrap resampling approach requires the indirect effect (*ab* coefficient) to be significantly different from zero.

When a mediated moderation effect was found, we examined the indirect effect (*c'* path; the interaction effect on CVR after controlling for the mediator). If the interaction effect still significantly predicts CVR after controlling for the mediator, the mediator only partially explains the interaction effect on CVR; if the interaction effect no longer significantly predicts CVR after controlling for the mediator, the mediator fully explains the interaction effect on CVR.

RESULTS

Preliminary Analyses

We examined the effects of social support, task engagement, and their interaction on age, height, weight, BMI, and baseline cardiovascular readings. There were no significant main effects or interaction effects on age, weight, and BMI, Fs < 2.45, ps > .120. However, there was a significant social support by task engagement interaction effect on height, $F(1, 116) = 4.19$, $p = .043$, $\eta^2 = .035$. Follow-up analyses testing the simple association between social support and height in each task engagement condition and the simple association between task engagement and height in each social support condition did not result in any significant associations, Fs < 2.60, ps > .110. Therefore, we considered the significant interaction spurious and unlikely to have a relevant effect on our outcomes.

There were significant task engagement main effects on SBP, DBP, and MBP baseline readings, Fs > 4.20, ps < .042. The participants randomly assigned to the low engagement condition (M = 121.07, SD = 12.10 for SBP; M = 75.53, SD = 9.78 for DBP; M = 93.81, SD = 10.23 for MBP) had higher baseline blood pressure readings than those assigned to the high engagement condition (M = 117.14, SD = 8.70; M = 72.02, SD = 8.21; M = 90.05, SD = 7.97). These results showed that, despite random assignment, the participants assigned to our experimental conditions differed significantly on height and baseline blood pressure.

We also examined the correlations among baseline cardiovascular readings, health behaviors, and CVR readings (see Tables 3, 4, and 5). As shown in Table 3, the baseline cardiovascular readings were not significantly associated with their corresponding CVR readings. However, higher HR reactivity was associated with greater average daily amount of

caffeinated drink and total weekly amount of vegetable intake (see Table 5). Therefore, we included these two health behavior variables as covariates in analyses involving HR reactivity.

Table 3
The Correlations between Cardiovascular Reactivity and Baseline Cardiovascular Readings

Variables	SBP reactivity	DBP reactivity	MBP reactivity	HR reactivity	Baseline SBP	Baseline DBP	Baseline MBP	Baseline HR
Mean	38.14	26.43	32.95	17.24	119.06	73.73	91.88	78.84
Standard deviation	15.09	9.30	11.09	14.08	10.64	9.15	9.30	10.72
SBP reactivity	1.00	0.84**	0.94**	0.40**	0.10	0.03	0.08	-0.12
DBP reactivity	0.84**	1.00	0.95**	0.46**	0.19*	0.18	0.21*	-0.14
MBP reactivity	0.94**	0.95**	1.00	0.44**	0.15	0.10	0.13	-0.17
HR reactivity	0.40**	0.46**	0.44**	1.00	0.24**	0.11	0.16	-0.17
Baseline SBP	0.10	0.19*	0.15	0.24**	1.00	0.72**	0.87**	0.06
Baseline DBP	0.03	0.18	0.10	0.11	0.72**	1.00	0.96**	0.10
Baseline MBP	0.08	0.21*	0.13	0.16	0.87**	0.96**	1.00	0.09
Baseline HR	-0.12	-0.14	-0.17	-0.17	0.06	0.10	0.09	1.00

Table 4

The Correlations between Cardiovascular Reactivity and Psychological Variables

Variables	1. SBPr	2. DBPr	3. MBPr	4. HRr	5. TE - V	6. TE - D	7. TE - A	8. IM - I/E	9. IM - E/I	10. IM - tension	11. IM - PC	12. Pretask SACL stress	13. Pretask SACL arousal	14. Posttask SACL stress	15. Posttask SACL arousal	16. Perceived social support
M	38.14	26.43	32.95	17.24	2.37	2.43	1.90	2.90	4.74	5.01	2.72	0.70	1.10	1.82	1.57	2.62
SD	15.09	9.30	11.09	14.08	0.76	0.71	0.85	1.22	1.37	1.44	1.40	0.47	0.51	0.75	0.48	0.96
2	0.84**	1.00														
3	0.94**	0.95**	1.00													
4	0.40**	0.46**	0.44**	1.00												
5	0.17	0.15	0.19*	0.04	1.00											
6	0.25**	0.19*	0.23*	0.09	0.54**	1.00										
7	0.25**	0.26**	0.29**	0.14	0.70**	0.52**	1.00									
8	0.22*	0.17	0.20*	0.14	0.57**	0.63**	0.54**	1.00								
9	0.25**	0.18*	0.25**	0.14	0.41**	0.49**	0.39**	0.32**	1.00							
10	0.11	0.15	0.14	0.20*	-0.30**	-0.14	-0.10	-0.40**	0.12	1.00						
11	0.19*	0.13	0.19*	0.02	0.62**	0.59**	0.52**	0.73**	0.34**	-0.49**	1.00					
12	0.12	0.11	0.13	0.04	-0.11	-0.13	0.03	-0.20*	0.05	0.36**	-0.23*	1.00				
13	0.10	-0.03	0.02	-0.06	0.28**	0.31**	0.17	0.34**	0.18	-0.24**	0.31**	-0.20*	1.00			
14	0.18	0.21*	0.21*	0.18	-0.41**	-0.31**	-0.21*	-0.49**	0.05	0.77**	-0.59**	0.43**	-0.31**	1.00		
15	0.32**	0.27**	0.33**	0.13	0.41**	0.39**	0.41**	0.37**	0.36**	0.03	0.30**	-0.05	0.25**	0.00	1.00	
16	0.15	0.10	0.15	0.01	0.39**	0.51**	0.31**	0.50**	0.29**	-0.34**	0.60**	-0.13	0.19*	-0.40**	0.38**	1.00

Note. ** $p < .01$, * $p < .05$. SBPr = systolic blood pressure reactivity, DBP = diastolic blood pressure reactivity, MBP = mean blood pressure reactivity, HR = heart rate reactivity, TE - V = task engagement – vigor, TE - D = task engagement – dedication, TE - A = Task engagement – absorption, IM = intrinsic motivation, I/E = interest/enjoyment, E/I = effort/importance, PC = perceived competence, SACL = stress/arousal checklist.

Table 5

The Correlations between Cardiovascular Reactivity and Health Behaviors

Variables	1. SBP reactivity	2. DBP reactivity	3. MBP reactivity	4. HR reactivity	5. Caffeinated drink[#]	6. Cigarettes smoked[#]	7. Alcoholic drink[#]	8. Aerobic exercise	9. Anaerobic exercise	10. Restrict food intake	11. Fruit intake	12. Vegetable intake
M	38.14	26.43	32.95	17.24	1.97	0.10	0.65	2.48	2.74	0.10	4.21	4.16
SD	15.09	9.30	11.09	14.08	2.64	0.44	1.02	2.01	2.11	0.30	2.23	2.03
2	0.84**	1.00										
3	0.94**	0.95**	1.00									
4	0.40**	0.46**	0.44**	1.00								
5	0.15	0.11	0.12	0.19*	1.00							
6	0.06	0.02	0.03	0.01	0.13	1.00						
7	0.06	0.09	0.06	0.07	0.07	0.02	1.00					
8	-0.01	-0.01	-0.01	0.09	-0.18*	-0.08	-0.10	1.00				
9	0.06	0.07	0.07	0.07	-0.11	-0.04	-0.01	0.58**	1.00			
10	-0.08	-0.06	-0.09	-0.01	0.06	0.11	0.03	0.06	0.01	1.00		
11	-0.01	0.02	-0.01	0.15	-0.09	-0.06	0.02	0.43**	0.22*	0.03	1.00	
12	0.06	0.08	0.06	0.20*	-0.05	0.02	0.02	0.21*	0.15	-0.18	0.60**	1.00

Note. ** $p < .01$, * $p < .05$. SBP = systolic blood pressure, DBP = diastolic blood pressure, MBP = mean blood pressure, HR = heart rate. Health behavior variables assessed the total amount of specific behavior occurred in the past 7 days, except for variables with superscripts [#], which denote the average amount taken per day in the past 7 days.

Manipulation Checks

Task stressfulness. To get an indication of whether our stress induction was effective, we were primarily concerned with comparing nonsupported participants' perceived stress, arousal, and cardiovascular readings during the baseline period to those during the stress task period. Therefore, we reported simple comparisons involving this subset of participants here and full factorial analyses in following sections. Results indicated an effective induction of stress. The nonsupported participants reported feeling more stressed, $t(58) = 12.44$, $p < .001$, and aroused, $t(55) = 5.21$, $p < .001$, during the speech task than during the baseline (see Table 6 for means and standard deviations). In addition, the nonsupported participants showed higher SBP, $t(58) = 18.74$, $p < .001$, DBP, $t(58) = 19.50$, $p < .001$, MBP, $t(58) = 21.28$, $p < .001$, and HR, $t(58) = 9.09$, $p < .001$, during the speech task than during the baseline (see Table 6). In sum, the speech task made the (nonsupported) participants feel stressed and aroused and increased their blood pressure and HR.

Table 6
The Means and Standard Deviations of Stress and Arousal Scores and Physiological Readings during Baseline and Task Periods among the Nonsupported Participants

Period		Subjective stress scores	Subjective arousal scores	Systolic blood pressure (mmHg)	Diastolic blood pressure (mmHg)	Mean blood pressure (mmHg)	Heart rate (beat per minute)
Baseline	*M*	0.73	1.11	118.42	73.37	91.36	78.8
	SD	0.43	0.52	11.68	0.87	9.33	11.43
Task	*M*	1.96	1.52	155.88	99.32	123.48	96.21
	SD	0.79	0.4	20.01	14.9	15.87	16.89

Notes. The baseline readings were significantly lower than the task readings in all the variables.

Task engagement manipulation. Among the nonsupported participants, those assigned to the high engagement condition (M = 2.46, SD = .79) reported a higher level of engagement on the vigor subscale of the Utrecht Work Engagement Scale (Schaufeli et al., 2002), indicating that they engaged in the task with more effort and energy than those assigned to the low engagement condition (M = 2.07, SD = .56), $F(1, 58) = 4.72$, $p = .034$, $\eta^2 = .075$. Compared to low engagement condition participants, high engagement participants reported being more dedicated to the task and absorbed in the task. However, these differences were not statistically significant, Fs < 1.02, ps > .310. These findings indicate that our task engagement manipulation was effective, particularly in terms of how much effort and energy were exerted.

Social support manipulation. The supported participants (M = 3.26, SD = .75) reported a significantly higher level of perceived social support than their nonsupported counterparts (M = 1.97, SD = .67), $F(1, 119) = 100.49$, $p < .001$, $\eta^2 = .458$, indicating an efficacious manipulation of social support.

Statistical Assumption Checks

We examined the assumptions of ANOVA before conducting hypothesis tests. Our data had relatively equal cell sizes, and our sample size was large enough to generate ANOVA error term degrees of freedom that were larger than 20 (Tabachnick & Fidell, 2007), suggesting that the data was robust to the violation of a normality assumption, if there was any.

There were two univariate outliers in SBP reactivity whose readings were more than 3.29 standard deviations higher and lower than the respective cell means. Before dealing with the outliers, we checked the homogeneity of variance assumption in order to rule out the possibility that the outliers were due to a violation of this assumption. The F_{max} scores of all DVs were

smaller than 10, indicating that the homogeneity of variance assumption was satisfied. Subsequently, we removed the two outliers (Field, 2013).

Hypothesis Testing

Hypothesis 1. The first hypothesis predicted that in the low engagement condition, the participants receiving social support would show greater blood pressure and HR responses to stress than those who received no support. In the high engagement condition, the participants who received social support would have lower blood pressure and HR responses than those who received no support.

Our two-way ANOVA results showed that the social support by task engagement interaction effect was marginally significant on MBP, $F(1, 116) = 3.73$, $p = .056$, $\eta^2 = .031$. We then examined the simple effect of social support in the high and low task engagement conditions respectively. In the low task engagement condition, the simple effect of social support was significant, $F(1, 57) = 4.51$, $p = .038$, $\eta^2 = .073$, where, as hypothesized, the supported participants had higher MBP reactivity than the nonsupported participants. In the high engagement condition, the MBP reactivity of the supported and nonsupported participants was not significantly different, $F(1, 59) = .41$, $p = .523$, although there was a tendency for the supported participants to show lower MBP reactivity than the nonsupported participants. Table 7 tabulates the group means and standard deviations, and Figure 2 shows the simple effect of social support in the low engagement and high engagement conditions.

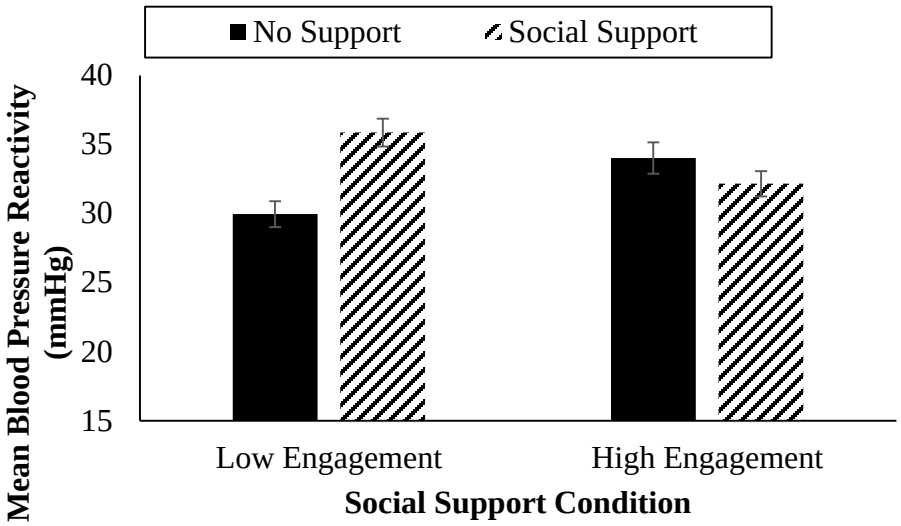

Figure 2. The social support by task engagement interaction effect on mean blood pressure reactivity.

To understand the interaction effect from another perspective, we examined the task engagement simple effect on MBP in the social support and no support conditions respectively. The task engagement simple effect on MBP was not significant in either social support conditions, *F*s < 1.88, *p*s > .170. However, there was a tendency for the high engagement condition to induce higher MBP reactivity than the low engagement condition in the no support condition and lower MBP reactivity than the low engagement condition in the support condition (see Table 7). This suggests that, in the absence of social support, being less engaged tended to decrease MBP responses. However, when social support was provided, there was a tendency for social support to elevate MBP reactivity in less engaged individuals.

Table 7

The Means and Standard Deviations of Cardiovascular Reactivity and Psychological Variables of the Socially Supported and Nonsupported Participants in the High and Low Engagement Conditions

Task engagement condition	Social support condition		Systolic blood pressure reactivity (mmHg)	Diastolic blood pressure reactivity (mmHg)	Mean blood pressure reactivity (mmHg)	Heart rate reactivity (beat per minute)	Intrinsic motivation inventory - interest/ enjoyment	Intrinsic motivation inventory - effort/ importance	Intrinsic motivation inventory - tension	Intrinsic motivation inventory - perceived competence
Low engagement	Social support	*M*	40.26	28.95	35.86	19.79	3.01	4.83	4.92	3.10
		SD	15.95	8.27	11.12	10.83	1.33	1.34	1.34	1.28
	No support	*M*	35.71	24.64	29.95	16.54	2.43	4.41	5.10	2.10
		SD	11.70	8.38	10.27	14.53	1.06	1.30	1.51	1.11
High engagement	Social support	*M*	37.93	25.23	32.16	14.44	3.24	4.91	4.77	3.04
		SD	14.22	8.24	10.07	15.22	1.28	1.47	1.45	1.56
	No support	*M*	38.63	27.07	34.02	18.50	2.93	4.82	5.28	2.63
		SD	11.71	11.78	12.55	15.26	1.12	1.38	1.46	1.42

The social support by task engagement interaction effect on DBP reactivity approached significance, $F(1, 116) = 3.31$, $p = .072$, $\eta^2 = .028$. Follow-up analysis showed that in the low engagement condition, socially supported participants had marginally significantly higher DBP reactivity than the nonsupported participants, $F(1, 57) = 3.95$, $p = .052$, $\eta^2 = .065$. In the high engagement condition, the two social support conditions did not differ in DBP reactivity, $F(1, 59) = .51$, $p = .479$. Analysis by social support condition showed that the simple effect of task engagement was not significant in the no support condition, $F(1, 57) = .84$, $p = .363$, and approached significance in the social support condition, $F(1, 59) = 3.08$, $p = .084$, $\eta^2 = .050$, such that, when not receiving support, the highly engaged participants had higher DBP reactivity than the low engagement participants, but when receiving support, the high engagement participants had lower DBP reactivity than low engagement participants (see Table 7).

The engagement by social support interaction effect was not significant on SBP reactivity, $F(1, 114) = 1.10$, $p = .296$, and HR reactivity, $F(1, 113) = .94$, $p = .335$. Despite the nonsignificant interaction effect, the effects of social support on SBP and HR reactivity in the high and low engagement conditions showed patterns similar to those found for MBP and DBP reactivity (see Table 7).

In sum, our results showed that social support increased DBP and MBP reactivity in the low engagement condition, but it had no significant effect in the high engagement condition. Further, social support had no significant effect on SBP and HR reactivity in either engagement conditions.

Hypothesis 2. Our second hypothesis predicted a mediated moderation effect. In particular, in the low engagement condition, relative to no support, social support would be associated with higher levels of motivation and effort, which in turn would be associated with

higher blood pressure and HR responses to stress. In the high engagement condition, social support would not be associated with motivation and effort, and higher motivation and effort would increase blood pressure and HR responses to stress.

Four mediated moderation analyses tested whether the moderation effect of task engagement in the association between social support and SBP reactivity could be explained by motivation (i.e., interest/enjoyment, effort, tension, and perceived competence). The social support by task engagement interaction was not significant on SBP reactivity to begin with (*c* coefficients < -1.05, *p*s > .325). Therefore, the mediators could not explain a nonsignificant effect. Nevertheless, we carried out our proposed analyses and found that other conditions were not satisfied to produce a mediated moderation. The social support by task engagement interaction effect on the mediators was not significant (*a* coefficients < -.04, *p*s > .390). Effort (*b* = 2.34, *p* = .011) were significantly positively associated with SBP reactivity, whereas interest/enjoyment, tension, and perceived competence (*b*s < 1.09, *p*s > .220) were not. After controlling for each mediator, the effects of social support on SBP reactivity in the high engagement (*c'* coefficients < -.00, *p*s > .05) and low engagement conditions (*c'* coefficients < -2.40, *p*s > .05) remained nonsignificant. The interaction effects on SBP reactivity via the mediators were not significant (*ab* coefficients < -.07).

Similar to SBP reactivity, the task engagement by social support interaction did not have a significant effect on DBP reactivity (*c* coefficients < -1.40, *p*s > .085), and therefore the mediators could not explain a nonsignificant effect. Other conditions of mediated moderation were not satisfied to produce a mediated moderation. The social support by task engagement interaction was not significantly associated with the motivation mediators (*a* coefficients < -.06, *p*s > .290). The mediators did not have significant associations with DBP reactivity (*b*

coefficients < 1.25, *p*s > .085). After controlling for each mediator, the effects of social support on DBP reactivity in the high engagement (*c'* coefficients < -.60, *p*s > .05) and low engagement conditions (*c'* coefficients < 2.25, *p*s > .05) remained nonsignificant. The interaction effects on DBP reactivity via the mediators were not significant (*ab* coefficients < -.07).

The social support by task engagement interaction effect on MBP reactivity was marginally significant (*c* coefficients < -1.70, *p*s > .067). However, other conditions were not fulfilled to suggest mediated moderation involving effort and motivation. In particular, the interaction effect was not significant on the motivation mediators (*a* coefficients < -.05, *p*s > .290). MBP reactivity was significantly associated with interest/enjoyment (*b* = 1.69, *p* = .046) and effort (*b* = 1.93, *p* = .010), but it was not significantly associated with tension and perceived competence (*b*s < 1.28, *p*s > .096). After controlling for each mediator, the effects of social support on MBP reactivity in the high engagement (*c'* coefficients < -.90, *p*s > .05) and the low engagement conditions (*c'* coefficients < 2.60, *p*s > .05) were not significant, with one exception. That is, after controlling for tension, social support had a significant effect on MBP reactivity in the low engagement condition (*b* = 3.06, *p* < .05) and no significant effect in the high engagement condition (*b* = -.58, *p* > .05). This suggests that after controlling for the effect of tension on MBP reactivity, social support was associated with higher MBP reactivity in the low engagement condition. However, since the interaction effects on MBP reactivity via the mediators were not significant (*ab* coefficients < -.10), there was no mediated moderation produced.

The motivation variables also did not explain a moderating effect of task engagement in the association between social support and HR reactivity. The social support by task engagement interaction effect was not significant on HR reactivity (*c* coefficients < -1.60, *p*s > .160). Further,

the interaction did not have significant effects on the motivation mediators (*a* coefficients < -.05, *p*s > .290). HR reactivity was not significantly associated with the mediators (*b*s < 1.78, *p*s > .102), except for tension (*b* = 1.90, *p* = .040). After controlling for each mediator, the effects of social support on HR reactivity in the high engagement (*c'* coefficients < -1.40, *p*s > .05) and low engagement conditions (*c'* coefficients < 1.80, *p*s > .05) remained nonsignificant. The interaction effects on HR reactivity via the mediators were not significant (*ab* coefficients < -.01).

Analyses of Psychological Data

We conducted a series of analyses to examine participants' subjective feelings of motivation, stress, arousal, social comfort, and social encouragement in situations we predicted to be socially encouraging and situations we predicted to be socially comforting. Unlike our manipulation checks, which involved only nonsupported participants, the following analyses are of the full 2 (task engagement) by 2 (social support) model.

Feelings related to motivation. Two-way engagement by social support ANOVAs performed on participants' self-reported psychological responses revealed that there were significant main effects of social support on interest/enjoyment, $F(1, 117) = 4.17$, $p = .043$, $\eta^2 = .034$, and perceived competence of the intrinsic motivation inventory (McAuley et al., 1989), $F(1, 117) = 8.22$, $p = .005$, $\eta^2 = .066$. Receiving social support made the participants feel more interested in the task, enjoyed the task more ($M = 3.13$, $SD = 1.29$), and felt more competent ($M = 3.07$, $SD = 1.42$) than those who did not receive support ($M = 2.68$, $SD = 1.11$ for interest/enjoyment; $M = 2.37$, $SD = 1.29$ for perceived competence). There were no other significant results in these analyses (all *p*s>.05). Thus, it appears that social support motivated its recipients regardless of the task engagement conditions.

Stress and arousal. To perform analyses on how social support affected subjective feelings of stress and arousal in high and low engagement situations, we subtracted baseline ratings from the task ratings of perceived stress and perceived arousal to obtain their respective change scores. We conducted two-way, social support by engagement ANOVAs on the change scores. The social support by task engagement interaction effects were not significant on stress, $F(1, 115) = .34$, $p = .561$, and arousal, $F(1, 115) = .30$, $p = .583$. However, there was a significant task engagement main effect on stress, $F(1, 115) = 6.96$, $p = .009$, $\eta^2 = .057$, such that the participants in the low engagement condition ($M = 1.28$, $SD = .70$) reported feeling more stressed than those in the high engagement condition ($M = .95$, $SD = .65$).

Self-reported feelings of social comfort and social encouragement. We tested how social support affected self-reported feelings of social comfort and social encouragement in high and low engagement situations. We performed two-way ANOVAs with social support and engagement as IVs and self-reports of social comfort (*How comforted did you feel*) and social encouragement (*The audience members motivated me*) as DV respectively. There were no significant interaction effects on social comfort, $F(1, 117) = .20$, $p = .653$, and social encouragement, $F(1, 117) = .29$, $p = .589$. However, there was a significant main effect of social support on social comfort, $F(1, 117) = 17.77$, $p < .001$, $\eta^2 = .132$, where the participants who received social support ($M = 2.87$, $SD = 1.15$) felt more comforted than those who received no support ($M = 2.00$, $SD = 1.10$). In addition, social support main effect was significant on social encouragement, $F(1, 117) = 101.64$, $p < .001$, $\eta^2 = .465$, where the socially supported participants felt more encouraged ($M = 4.00$, $SD = 1.17$) than the nonsupported participants ($M = 1.85$, $SD = 1.16$). These findings indicated that receiving social support, in general, made our participants feel both comforted and encouraged.

Subsequently, we investigated how subjective feelings of social encouragement and social comfort were related to changes in self-reported stress and arousal levels among the supported participants in the high and low engagement conditions. In the high engagement condition, when the supported participants felt more encouraged, they also had a stronger feeling of arousal, $r(31) = .37$, $p = .042$. When they felt more comforted, they had a lower level of subjective stress, $r(31) = -.47$, $p = .007$. In the low engagement condition, subjective feelings of social comfort and social encouragement were not associated with stress and arousal, rs $< .29$, ps $> .156$.

DISCUSSION

Key Findings

This study partially supported our hypotheses. Consistent with our prediction, in less engaging situations, participants who received social support responded to a stressful speech task with greater CVR (MBP and DBP) than those who did not receive support, indicating a social encouragement effect of social support. When the speech topic was more engaging, there was no significant effect of social support on CVR. Therefore, there was support for the general hypothesis that task engagement would moderate the effect of support on CVR. Also, our specific hypothesis that social support would increase CVR in less engaging situations was supported. However, we did not find support for our specific hypothesis that social support would reduce CVR when a task was more engaging. This latter nonsignificant effect is curious as it is the effect most often reported in social support, CVR research (see Uchino et al., 1997 for a review).

We performed analyses to examine how feelings of comfort and encouragement were associated with feelings of stress and arousal. In the less engaging situation where we predicted social support would be primarily encouraging, perceived social encouragement was associated with greater subjective arousal. In contrast, in the more engaging situation, where we predicted social support would be primarily comforting, perceived encouragement and perceived comfort were not associated with subjective arousal. Although self-reported comfort and encouragement were not significantly associated with objective CVR, this pattern of results involving subjective arousal is consistent with our prediction that social support would increase arousal in the less engaging condition by encouraging participants. Further, we hypothesized that the primary

influence of social support in the more engaging condition would not be to encourage, consistent with the lack of association with subjective arousal in this condition.

As the first empirical study that tested the dual effect model of social support and stress (Teoh & Hilmert, 2015), these findings have some important theoretical implications.

Theoretical Implications

The dual effect model (Teoh & Hilmert, 2015) proposed two differential psychophysiological effects of social support. In particular, this model suggests that social support induces a social encouragement effect in less engaging situations and a social comforting effect in more engaging situations.

Social encouragement in less engaging situations. A less engaging situation is conducive to a social encouragement effect, but not a social comforting effect. In some stressful situations, people feel discouraged or not motivated to deal with the situations. However, an important way to decrease stress is actually to engage, actively seek out, and apply resources available to cope with stress. In this case, it is conducive for social support to encourage and motivate people to deal with stress actively. For instance, instead of doing nothing and feeling stressed about being surrounded by a group of strangers in a party, greeting people and initiating conversations is a better way to deal with the social stress. In this situation, friendly gestures from one of the strangers may help encourage the person to reach out to the strangers. On the other hand, a less engaging condition does not facilitate social comforting effect, which aims to attenuate heightened physiological responses. When people are less engaged in a social situation, demonstrating lower physiological responses, social support cannot attenuate physiological responses that are already low.

Comparing our study outcomes with those from the study by Hilmert, Kulik et al. (2002), both studies lend support to the hypothesized social encouragement effect of the dual effect model (Teoh & Hilmert, 2015). According to the model, social encouragement occurs in less engaging situations, situations that resemble the "very difficult" and "easy" conditions of the study by Elliott (1969). Our low engagement condition had participants give a speech on a topic they ranked as least engaging. This topic was one that participants reported as being the least interesting and most difficult, and that the participants would be least confident in and would devote the least effort to. Our design was intended to resemble the "very difficult" low motivation condition of Elliott's (1969) study. In contrast, the study by Hilmert, Kulik et al. (2002), in which the participants gave a speech to an audience member in the presence or absence of an experimenter, the experimenter absence condition resembled the "easy" low motivation condition of Elliott's study. The participants in both the "very difficult" and "easy" conditions of Elliott's study responded with minimal HR reactivity and a decrease in motivation. Our study and Hilmert et al.'s study further demonstrated that providing social support in these types of situations provided encouragement, elevating the originally low blood pressure responses.

The elevation in CVR resulting from social encouragement is likely a healthful response pattern. Heightened CVR has been associated with detrimental cardiovascular health, but this association develops over a long period of time (Treiber et al., 2003). The CVR-elevating effect of social encouragement likely lasts for a short period of time and is infrequent, possibly resulting in a good 'investment' for health. Moreover, the CVR pattern of social encouragement might be similar to healthful physiological response patterns observed during exercise (e.g., involving less vascular resistance), rather than unhealthy physiological responses to threat (e.g.,

involving more vascular resistance; Nobrega et al., 2014; Tomaka, Blascovich, Kelsey, & Leitten, 1993).

Social comfort in more engaging situations. Our findings did not support the hypothesized social support comforting effect in more engaging situations. When the participants were giving a speech on a more engaging topic, receiving social support did not lower CVR relative to when giving a speech on an engaging topic while not supported.

There are two factors that could explain the absence of a notable social comforting effect in the high engagement condition. First, among nonsupported participants, although there was a tendency for participants in the high engagement condition to have higher blood pressure reactivity than those in the low engagement condition, this difference was not statistically significant. Past research suggests that greater motivation (or task engagement) is associated with greater physiological arousal (Wright & Kirby, 2001). And when social support is introduced into a high engagement situation, we expected it to serve a primarily comforting purpose, attenuating a heightened stress level and associated CVR to stress. However, in terms of physiology, our results suggest that participants in the high engagement condition were not significantly more engaged or motivated than those in the low engagement condition.

In stressful, high engagement situations, CVR is likely a reflection of a combination of greater task engagement and psychological stress (Rousselle, Blascovich, & Kelsey, 1995; Teoh & Hilmert, 2015). Therefore, the nonsignificant difference in CVR between our two engagement conditions may be because the task engagement level was not high enough and/or the stress level was not high enough. Although high engagement participants reported feeling more engaged than our low engagement participants, it is possible that this difference was between "somewhat" engaged and less engaged. That is, considering the model depicted in Figure 1, while our low

engagement participants were representative of the upper left quadrant of the model, our high engagement participants may not have been representative of the lower right quadrant, but instead were experiencing the stress and engagement depicted by the middle of Figure 1. Consistent with this, our participants in the "high" engagement condition reported feeling less stressed than those in the low engagement condition, indicating that these participants may not have felt the stress social support would have reduced. Moreover, the stress level could be so low that it might have induced low task engagement, resembling the "easy" rather than "very difficult" condition of Elliott's (1969) study. Regardless, these results suggest that the impact of a laboratory stressor on physiology may be more variable and tenuous than previously considered.

Although a lower-than-expected CVR level was not conducive to a social support comforting effect, it is interesting that participants still said they felt supported. That is, receiving social support, regardless of task engagement conditions, made the recipients in our study feel supported. In the less engaging condition, this perceived social support was correlated with an increase in CVR. In the more engaging condition, social support was not associated with CVR. Thus, multiple effects of social support are evident here.

Nonsignificant SBP, HR, and motivation findings. The interaction effects between social support and task engagement on SBP and HR responses and on self-reported motivation and effort were not significant in our study. Research has shown that HR responses are more sensitive to and are positively associated with the amount of effort put forth (Fowles, 1980). Therefore, the lack of significant interaction effect on HR responses in our study might be related to an ineffective physiological manipulation of engagement and effort. It is not clear why we did

not find a SBP reactivity result similar to the DBP reactivity result as these parameters are usually closely correlated (Hilmert, Kulik et al., 2002).

To better understand how social comfort and social encouragement played roles in this study, we engaged in analyses of some underlying mechanisms.

Mediated Moderation Analyses

Our study showed that self-reported motivation and effort did not mediate the moderation effect of task engagement on the association between social support and blood pressure. This could be due to an insensitive measure of effort. We measured effort using a four-item subscale, including perceived amount of effort, perceived importance to do well, and try very hard to do a task (two items). This subscale did not measure other aspects of effort, for instance, how willing one is to put forth effort, which can cause bias in self-reported effort. When one is willing to put forth effort, s/he might tend to underestimate the actual amount of effort put forth. Also, the subscale did not specifically measure mental effort. Preparing for a speech in 5 minutes without a pen and paper and deliver a five-minute speech in front of audience requires a large amount of mental effort. In addition, we had no objective indicator of effort, such as the amount of words used (Hilmert, Christenfeld et al., 2002) and the number of arguments proposed in a speech, which may have been sensitive to important aspects of effort.

It is possible that effort was not a primary mediator of the observed effect, and that other factors might have accounted for the variance significantly. For instance, research has shown that receiving social support before or while performing a cognitive task enhances cognitive performance (e.g., Sarason & Sarason, 1986). Thus, increased motivation resulting from a social encouragement effect may enhance cognitive processing and sharpen our attention (Engelmann & Pessoa, 2014). Increasing cognitive processes and sharpening attention has been associated

with elevated physiological arousal (Fried & Grimaldi, 1993; Gray, 1987). Conversely, because stress narrows our scope of attention (Cohen, 1980), stress-buffering resulting from a social comfort effect might widen our scope of attention, increasing awareness of the vast amount of resources available to cope with stress. This awareness might decrease blood pressure responses to stress (Lepore, 1998).

Extrinsic motivation is another potential mediator. The motivation measured in this study was intrinsic motivation, including interest, enjoyment, and perceived competence. Social support that involves praise and encouragement could enhance intrinsic motivation, as shown in our study. In addition, it is likely that social support increases extrinsic motivation to enhance the support recipients' awareness of instrumental factors, such as reward and punishment associated with the task, and to meet the expectation of support providers (Deci & Ryan, 2002). In this case, social support in a high engagement situation signals that the participant achieves a positive outcome (reward), resulting in a decrease in CVR. Social support in a low engagement situation may signal that the demands of the situation are not as great as originally assumed, and that a reward that seems unlikely is instead attainable.

What we learned about the social comforting and social encouragement effects of social support and their underlying mechanisms are helpful in predicting how social support benefits its recipients in various social situations, such as at workplace and in medical settings.

Practical Implications

There are stressful situations in which people are likely to disengage. Disengaging from a stressful situation may affect physical and psychosocial health in negative ways. For instance, when people are less engaged (or disengaged) at work and at school, feeling less motivated to perform their duties because the duties are too difficult (Harrington, 2005) or boring (Wan,

Downey, & Stough, 2014), they are likely to procrastinate. Procrastinating from responsibilities at work will reduce productivity, affect colleagues' work progress, create a hostile work environment, and increase stress (Stead, Shanahan, & Neufeld, 2010; Tice & Baumeister, 1997). Procrastination at school will affect school grades, increase stress, and increase risk of poorer health (Tice & Baumeister, 1997). Similarly, complicated, strenuous treatment regimens can be stressful and frustrating, causing patients to disengage and not follow through with prescribed medical treatments (Simons & Blount, 2007). Disengaging from uncontrollable stress in one's life may lead to a generalized disengagement in the form of social withdrawal, increasing the risk of depression and adversely affecting health (Friedman-Wheeler, Haaga, Gunthert, Ahrens, & McIntosh, 2008; Van den Elzen & MacLeod, 2006).

Based on the dual effect model of social support (Teoh & Hilmert, 2015) and the findings of our study, social support provides encouragement in situations in which participants are less likely to engage. Social support may influence people who would otherwise choose to procrastinate in less engaging situations to feel encouraged and motivated to perform job duties or to study instead of procrastinate. Social support may help them by focusing their attention to the task at hand. Patients who would otherwise not adhere to treatment regimens may feel encouraged when receiving social support, increasing the likelihood of actively participating in treatment regimens instead of avoiding them (Cicero et al., 2009). Social support may influence the patients by increasing their focus on the positive outcomes of treatments, such as physical well-being and autonomy. Depressed individuals may benefit as much from a social encouragement effect of social support as a social comfort effect (Fankhauser, Drobetz, Mortby, Maercker, & Forstmeier, 2014). Feeling encouraged to connect to their social networks and

environments can be a key component to recovery from depression. Social support, in this case, may direct their focus to things that are controllable and rewarding.

Other stressful situations are more likely to lead to engagement, and, even with active engagement, the response may be excessive and have detrimental effects on physical and psychological health. For instance, impending possibilities of getting promoted or getting fired at workplace might engage people to work hard and fear they are not working hard enough. Stressed by these motivations, some people might overwork without break, increasing the chances of cardiac sudden death (International Labour Organization, 2013). Stressful, competitive settings (e.g., sports and other forms of competitions) might inspire overexertion. Athletes who practice excessively might damage their muscle tissues, which debilitates their performance (Heckhausen & Strang, 1988). In addition, people engaged in stressful situations repeatedly are more likely to consume alcohol, and this unhealthy behavior is reinforced by the pleasing stress-buffering effect of drinking. Over time, when they are engaged but also drinking excessively, they put themselves in danger of CVD (Ronksley, Brien, Turner, Mukamal, & Ghali, 2009).

According to the dual effect model of social support and stress (Teoh & Hilmert, 2015), in highly engaging situations, social support may comfort people by attenuating negative emotional responses and heightened CVR. This could potentially mitigate stress-related psychological and physical health complications. For example, in more engaging situations, providing social support to people who overwork may assuage their anxiety about getting promoted or fired, broadening their scope of focus on other things in their lives, such as families, friends, and helpful work-related resources. Social support provided to athletes who practice too hard may ease the athletes' stress levels and enhance their performance (Freeman & Rees, 2009).

Social support may help alcoholics control their drinking behaviors in situations that engage them to drink (however, social interaction with drinkers should not be confused with positive social support). In this case, social support may invite them to other healthy ways to cope with stress. It is important to note that when serving as social comfort, social support does not compromise task performance (Kamarck, Manuck, & Jennings, 1990; Sarason & Sarason, 1986). Therefore, social support can comfort people who overwork, athletes who overpractice, and people who drink excessively, but not necessarily affect their engagement in tasks or responsibilities related to excessive stress reactions.

Limitations and Suggestions for Future Studies

While the findings of our study provided partial support for the dual effect model of social support and stress (Teoh & Hilmert, 2015), there are certain issues to take into consideration when interpreting our findings.

First, the results pertaining to our high engagement condition have to be interpreted with caution. It appears that our high engagement condition did not induce a high enough level of stress, engagement, and/or CVR and hence might have inadvertently created a situation appropriate for social encouragement rather than social comfort. Future studies should take more precautions when manipulating task engagement, keeping in mind that it is important to induce task engagement that also increases effort, stress level, and physiological responses.

Second, since the effort measure we used in this study might not have adequately measured all aspects of effort, future research should try other multidimensional effort measures that include, for instance, assessments of mental effort and behavioral effort. Additionally, future studies should consider other potential mediators, such as cognitive processes and extrinsic motivation.

Future research may benefit from conducting translational research on the dual effect model (Teoh & Hilmert, 2015) in applied settings. In particular, it may be important to examine the health benefits of social support in encouraging procrastinators, patients who refuse to follow treatment regimens, and depressive individuals in less engaging situations. In addition, it may be important to test the health benefits of social support in comforting, for instance, people who overwork, athletes who overpractice, and people who drink profusely in more engaging situations.

Conclusion

This study aimed to fill the gap in literature that examined the association between social support and CVR. As research has reported inconsistent findings on the effect of social support on CVR, the dual effect model (Teoh & Hilmert, 2015) suggests that the inconsistent findings could be due to differential psychophysiological effects of social support in situations varying in task engagement. Therefore, we hypothesized that social support would encourage people who disengage in stressful, disengaging situations, as would be manifested in heightened physiological responses. Also, social support would comfort people who engage in stressful, engaging situations, as would be manifested in attenuated physiological responses. Our findings provided partial support to the hypotheses. When participants were made less engaged to a stressful speech task, social support increased blood pressure responses relative to no support. However, when participants were made more engaged in the speech task, social support had no effect on CVR.

Past research has listed a bulk of general healthful effects of social support. Our study adds to this, identifying the varied psychophysiological effects of social support during stress in more engaging and less engaging situations. A better understanding of the benefits social support

under certain situations provides a more holistic view on the associations among social support, stress, and health.

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APPENDIX A. PILOT STUDY CONSENT FORM

NDSU **North Dakota State University**
Department of Psychology
232 Minard Hall
Fargo, ND 58108-6050

Title of Research Study: Attitudes about Challenging Tasks (ACT) Survey

This study is being conducted by: Dr. Clayton Hilmert, Associate Professor in the Department of Psychology at NDSU (Clayton.Hilmert@ndsu.edu).

Why am I being asked to take part in this research study?
You are invited to take part in this research study because you are enrolled in a Psychology class at North Dakota State University. Your participation is entirely your choice, and you may change your mind or quit participating at any time, with no penalty to you.

What is the reason for doing the study?
The purpose of the study is to better understand people's attitudes about certain challenging tasks such as exercising, public speaking, or working on math problems.

What will I be asked to do?
If you agree to participate in this study, you will answer questions on a battery of questionnaires.

Where is the study going to take place, and how long will it take?
The questionnaires are posted online. After you read the consent form and are willing to participate in this study, you will click on the continue button to indicate your consent to participate. Following this you will be asked to complete the ACT Survey online. The experiment will take about 15 minutes to complete.

What are the risks and discomforts?
The only risks and discomforts involved in this study are the possible loss of confidentiality.

What are the benefits to me?
By participating in this study, you may benefit by learning more about how research is conducted. However, you may not get any benefit from being in this study.

What are the benefits to other people?
You will help researchers learn more about how people think of challenging tasks, and help in the advancement of knowledge.

Do I have to take part in the study? Your participation in this research is your choice. If you decide to participate in the study, you may change your mind and stop participating at any time without penalty or loss of benefits to which you are already entitled.

Who will have access to the information that I give?

Your responses and consent form will be kept separately. Your information will be coded with unidentifiable numbers and combined with information from other people taking part in the study. When we write about the study, we will write about the combined information that we have gathered. We may publish the results of the study; however, we will keep your name and other identifying information private.

We will make every effort to prevent anyone who is not on the research team from knowing that you gave us information, or what that information is. For example, your name will be kept separate from your research records and these two things will be stored in different places under lock and key.

Will I receive any compensation for taking part in this study?
You will receive one extra credit point for participating in this research session due to this session lasting approximately 15 minutes. If you choose to withdraw from this study, you will be awarded extra credit points for how many minutes you were in the study.

What if I have questions?
Before you decide whether to accept this invitation to participate in the research study, please ask any questions that might come to mind now. Later, if you have any questions about the study, you can contact the researcher, Dr. Clayton Hilmert at 701.231-5148, or Clayton.Hilmert@ndsu.edu.

What are my rights as a research participant?
You have rights as a participant in research. If you have questions about your rights, or complaints about this research, you may talk to the researcher or contact the NDSU Human Research Protection Program at:

- Telephone: 701.231.8908
- Email: ndsu.irb@ndsu.edu
- Mail: NDSU HRPP, 1735 NDSU Research Park Dr., NDSU Dept. 4000, PO Box 6050, Fargo, ND 58108-6050

The role of the Human Research Protection Program is to see that your rights are protected in this research; more information about your rights can be found at: www.ndsu.edu/research/irb .

Documentation of Informed Consent:
You are freely making a decision whether to be in this research study. Completing the survey means that

1. you have read and understood this consent form
2. you have had your questions answered, and
3. you have decided to be in the study.

You will be given a copy of this consent form to keep.

APPENDIX B. PILOT STUDY QUESTIONNAIRE

Example List of Speech Topics

1. Euthanasia (helping someone die because of a medical condition)
2. Pornography
3. Why you are a good friend
4. Homosexuals in the US military
5. Should NDSU increase student fees?
6. Should NDSU provide more parking for students?
7. What you like about yourself
8. What you dislike about yourself
9. The NDSU football team
10. Birth control
11. online courses versus on-campus courses
12. Abortion
13. Evolution and religion
14. Teaching creationism in public schools
15. Religion and morality
16. Sexually transmitted infections
17. How to choose a wine
18. Islam and terrorism
19. Adoption by gay and lesbian families
20. The existence of Aliens
21. Animals have emotions
22. The US should cut off all foreign aid to dictatorships
23. Legalizing prostitution
24. Best places to eat and drink in Fargo
25. Your favorite food
26. Binge drinking on college campuses
27. The Greek (Fraternity/Sorority) System
28. Why an employer should hire you
29. Fairness of assessment in NDSU classes
30. Barack Obama

Questionnaire

Please describe how you would feel if you were asked to give a speech on the topic _____ to an audience of 50-100 people. There are no right or wrong answers, only what is true for you. Please answer as honestly as possible.

1. How **difficult** would it be for you to give a speech on this topic?

1	2	3	4	5	6	7	8	9
very easy								very difficult

2. How **confident** would you be to give a speech on this topic?

1	2	3	4	5	6	7	8	9
not at all confident					neutral			very confident

3. How **interested would you be to give a speech on** this?

1	2	3	4	5	6	7	8	9
very interested				neutral				not at all interested

4. How much **effort** would you put into the task?

1	2	3	4	5	6	7	8	9
very much				neutral				not at all

APPENDIX C. PRETASK SCALE

Below you are asked to **rank order** different tasks in terms of your feelings about the tasks. There are no right or wrong answers to the questions, just what is true for you. Please read each question carefully and answer as honestly as possible.

1. If you were to give a speech, how would the topic of your speech affect the amount of effort you could put into the task? Please **rank order** the speech topics in terms of the **amount of effort** you would be able to put forth if you were asked to give a speech on the topic.

   1 = put forth the least effort; 6 = put forth the most effort
   (Please use each rank only once.)

   _____ Pornography

   _____ Birth Control

   _____ Why an Employer Should Hire You

   _____ Legalizing Prostitution

   _____ Animals Have Emotions

   _____ Islam and Terrorism

2. If you were to perform a math task, how would the arithmetic and starting point affect your interest in the task? Please **rank order** the math tasks in terms of how **comfortable** you would be if you were to perform that task.

   1 = the least comfortable; 6 = the most comfortable
   (Please use each rank only once.)

   _____ Count down from 2331 by 13s

   _____ Count down from 2331 by 2s

   _____ Count up from 1441 by 13s

   _____ Count up from 1441 by 2s

   _____ Count up from 2331 by 13s

   _____ Count down from 1441 by 13s

3. If you were to give a speech, how would the topic of your speech affect your interest in the task? Please **rank order** the speech topics in terms of how **interested** you would be if you were asked to give a speech on the topic.

   1 = the least interested; 6 = the most interested
   (Please use each rank only once.)

   _____ Why an Employer Should Hire You

   _____ Legalizing Prostitution

   _____ Islam and Terrorism

   _____ Animals Have Emotions

   _____ Pornography

   _____ Birth Control

4. If you were to give a speech, how would the topic of your speech affect your confidence in the task? Please **rank order** the speech topics in terms of how **confident** you would be if you were asked to give a speech on the topic.

   1 = the least confident; 6 = the most confident
   (Please use each rank only once.)

   _____ Islam and Terrorism

   _____ Why an Employer Should Hire You

   _____ Pornography

   _____ Animals Have Emotions

   _____ Legalizing Prostitution

   _____ Birth Control

5. If you were to give a speech, how would the topic of your speech affect your perceived difficulty of the task? Please **rank order** the speech topics in terms of how **difficult** it would be for you if you were asked to give a speech on the topic.

   1 = the most difficult; 6 = the easiest

   (Please use each rank only once.)

   _____ Animals Have Emotions

   _____ Islam and Terrorism

   _____ Pornography

   _____ Legalizing Prostitution

   _____ Birth Control

   _____ Why an Employer Should Hire You

APPENDIX D. PERCEIVED SOCIAL SUPPORT SCALE

Instructions: Please answer each question by putting a circle around the most appropriate number from a scale of 1 to 5. There are no right or wrong answers, and no trick questions.

During the task,

	Not at all				**Very Much**
How supported did you feel?	1	2	3	4	5
How satisfied were you with the support you received?	1	2	3	4	5
The audience members were very helpful.	1	2	3	4	5
The audience members motivated me.	1	2	3	4	5
To what extent did the audience members give suggestions?	1	2	3	4	5
The presence of the audience members made me more nervous than I would have been alone.	1	2	3	4	5
How comforted did you feel?	1	2	3	4	5
The reaction of the audience members made me try harder.	1	2	3	4	5
The reaction of the audience members relieved my nervousness.	1	2	3	4	5
How confident did you feel?	1	2	3	4	5
How acknowledged did you feel?	1	2	3	4	5

APPENDIX E. STRESS/AROUSAL ADJECTIVE CHECKLIST

Instructions: Please answer each question truthfully on how you felt **during the task** by putting a tick in the most appropriate box. There are no right or wrong answers, and no trick questions.

		0. Definitely No	1. A Little	2. Quite a bit	3. Definitely Yes
1	Calm				
2	Contented				
3	Comfortable				
4	Uneasy				
5	Worried				
6	Distressed				
7	Uptight				
8	Tense				
9	Relaxed				
10	Bothered				
11	Active				
12	Vigorous				
13	Lively				
14	Sleepy				
15	Drowsy				
16	Energetic				
17	Alert				
18	Tired				
19	Passive				
20	Aroused				

APPENDIX F. MODIFIED INTRINSIC MOTIVATION INVENTORY

The following are statements to describe how you felt during the task. Read each statement and then put in the 'Response' column the most appropriate number that indicates how you **FELT DURING THE SPEECH**. There are no right or wrong answers. Do not spend too much time on any one statement, but give your answer which seems BEST DESCRIBE YOUR FEELINGS.

1	2	3	4	5	6	7
Not At All						**Very Strongly So**

Items	Response
1. While I was working on the task I was thinking about how much I enjoyed it.	
2. I put a lot of effort into the task.	
3. It was important to me to do well at the task.	
4. I tried very hard while doing the task.	
5. I could do the task very well.	
6. I felt tense while doing the task.	
7. I think I did pretty well at this activity, compared to other students.	
8. Doing the task was fun.	
9. I felt relaxed while doing the task.	
10. I enjoyed doing the task very much.	
11. I felt pretty skilled at this task.	
12. I am satisfied with my performance at this task.	
13. I was anxious while doing the task.	
14. This task did not hold my attention.	
15. I did not try very hard at the task.	
16. I felt pressured while doing the task.	
17. I would describe the task as very interesting.	
18. After working at this task for a while, I felt pretty competent.	

APPENDIX G. MODIFIED UTRECHT WORK ENGAGEMENT SCALE

Please answer each question truthfully on how you **felt during the task** by putting the most appropriate number in the box. Use the following scale to record your answers:

1 2 3 4 5
Strongly Disagree Strongly Agree

☐ 1. When I was preparing for the speech task, I feel like giving the speech.

☐ 2. When I was preparing for the speech and giving the speech, I felt bursting with energy.

☐ 3. During the speech task I always persevered, even when the speech did not go well.

☐ 4. I can continue giving a speech for very long periods at a time.

☐ 5. During the speech task I was very resilient, mentally.

☐ 6. During the speech task I felt strong and vigorous.

☐ 7. To me, the speech task was challenging.

☐ 8. The speech task inspired me.

☐ 9. I was enthusiastic about the speech task.

☐ 10. I was proud of the speech I gave.

☐ 11. I find my speech full of meaning and purpose.

☐ 12. When I was giving the speech, I forgot everything else around me.

☐ 13. Time flies when I was giving the speech.

☐ 14. I got carried away when I was giving the speech.

☐ 15. It was difficult to detach myself from the speech task.

☐ 16. I was immersed in the speech task.

☐ 17. I felt happy when I was giving the speech intensely.

APPENDIX H. HEALTH AND DEMOGRAPHIC QUESTIONNAIRES

Health Questionnaire

Instructions: The present investigation provided measurements of heart rate and blood pressure, and therefore we want to identify factors which may affect these responses during the investigation. Please answer the following questions. All information that you provide will remain confidential, and feel free not to answer any questions that you feel uncomfortable in completing. If you have any questions as you go along, please ask the experimenter for clarification. Thank you.

Please answer the following questions regarding your behavior TODAY and THIS PAST WEEK, as indicated in the question:

1. **So far today**, how many cups of coffee (or 8-12 oz. serving of another caffeinated drink, i.e. cola) did you have? (indicate the number below)

_____cups of coffee or cola

2. In the **past HOUR**, have you had a cup of coffee (or 8-12 oz. serving of another caffeinated drink, i.e. cola)?

YES NO

3. Over the **past 7 days**, how many cups of coffee (or 8-12 oz. serving of another caffeinated drink, i.e. cola) have you had per day, on average?

_____ cups of coffee or cola

4. **So far today**, how many cigarettes have you smoked?

_____cigarettes

5. Over the **past 7 days**, how many cigarettes have you smoked per day, on average?

_____cigarettes

6. **So far today**, how many drinks containing alcohol (beer, wine, a mixed drink) have you consumed?

_____drinks containing alcohol

7. How often **over the past 7 days** have you had a drink containing alcohol (beer, wine, a mixed drink, any kind of alcoholic beverage)?

_____days

8. On days this **past week (7 days)** when you drank alcoholic beverages, how many drinks did you have all together on an average day? (By a drink, we mean a can or glass of beer, a 4-ounce glass of wine, a 1½ ounce shot of liquor, or a mixed drink with that amount of liquor).

_____drinks containing alcohol.

9. What was the most you had to drink in any **given 24-hour period** over the **past 7 days**?

_____drinks containing alcohol

10. **Today**, have you engaged in physical exercise, such as running, swimming, bicycling, tennis, fast walking, yoga, baseball, stretching?

1. No
2. Yes, for under 30 minutes
3. Yes, 30 minutes or more

11. Over the **past 7 days**, how many days did you engage in aerobic exercise: vigorous and continuous activity such as running, swimming, bicycling?

0	1	2	3	4	5	6	7

12. Over the **past 7 days**, how many days did you engage in anaerobic exercise: short burst of activity such as tennis, fast walking, yoga, baseball, stretching?

0	1	2	3	4	5	6	7

13. Did you greatly restrict your food intake over the **past 7 days**?

YES NO

If yes, how many days this week did you restrict your food intake?

0	1	2	3	4	5	6	7

14. Did you binge at any time over the **past 7 days** (eat unusually large quantities of food in a very short period of time)?

YES NO

If yes, how many days this week did you binge eat?

0	1	2	3	4	5	6	7

15. **Today**, have you taken any prescription drugs (including birth control)?

YES NO

If yes, please list below:

16. **DURING THE PAST 7 DAYS**, how many days did you eat breakfast?

_____days this week

17. Did you eat breakfast **today**? YES NO

18. **DURING THE PAST 7 DAYS**, how many days have you eaten fruit?

_____days this week

19. Have you eaten fruit **today**? YES NO

20. **DURING THE PAST 7 DAYS**, how many days have you eaten vegetables?

_____days this week

21. Have you eaten vegetables **today**? YES NO

22. In the past **HOUR**, have you eaten any chips? YES NO

23. In the past **HOUR**, have you had any dairy products (milk, yogurt, cheese, etc.)?

YES NO

24. Do you have any of the following medical conditions? Please read the list below and then answer yes (Y) if you have any of the conditions below. You do not need to indicate which of these conditions you have, just answer yes if anything on the list applies to you. If you do not have any of these conditions, please answer no (N).

Y/N

_____ An endocrine disorder, such as Cushing's syndrome or Addison's disease
_____ An autoimmune disorder, such as lupus, rheumatoid arthritis, or multiple sclerosis
_____ A severe immune disease, such as HIV infection or AIDS
_____ A metabolic disease, such as adult diabetes, hypoglycemia, or hyperglycemia
_____ Chronic Fatigue Syndrome
_____ A diagnosed anxiety or depressive disorder (within last 6 months)
_____ A chronic infectious disease, such as hepatitis, tuberculosis, mononucleosis, etc.
_____ Any form of cancer or tumor
_____ A blood disease such as hemophilia or leukemia
_____ Serious allergies or asthma as an adult
_____ A cardiovascular condition, such as hypertension
_____ If you have been pregnant or breastfed in the last 6 months

INSTRUCTIONS:
The following questions relate to your usual sleep habits during the past month only. Your answers should indicate the most accurate reply for the majority of days and nights in the past month.
Please answer all questions.

1. During the past month, what time have you usually gone to bed at night?
BED TIME _____

2. During the past month, how long (in minutes) has it usually taken you to fall asleep each night?
NUMBER OF MINUTES _____

3. During the past month, what time have you usually gotten up in the morning?
GETTING UP TIME _____

4. During the past month, how many hours of actual sleep did you get at night? (This may be different than the number of hours you spent in bed.)
HOURS OF SLEEP PER NIGHT _____

For each of the remaining questions, check the one best response. Please answer all questions.

5. During the past month, how often have you had trouble sleeping because you . . .

a) Cannot get to sleep within 30 minutes

Not during the past month_____	Less than once a week_____	Once or twice a week_____	Three or more times a week_____

b) Wake up in the middle of the night or early morning

Not during the past month_____	Less than once a week_____	Once or twice a week_____	Three or more times a week_____

c) Have to get up to use the bathroom

Not during the past month_____	Less than once a week_____	Once or twice a week_____	Three or more times a week_____

d) Cannot breathe comfortably

Not during the past month_____	Less than once a week_____	Once or twice a week_____	Three or more times a week_____

e) Cough or snore loudly

Not during the past month_____	Less than once a week_____	Once or twice a week_____	Three or more times a week_____

f) Feel too cold

Not during the past month_____	Less than once a week_____	Once or twice a week_____	Three or more times a week_____

g) Feel too hot

Not during the past month_____	Less than once a week_____	Once or twice a week_____	Three or more times a week_____

h) Had bad dreams

Not during the past month_____	Less than once a week_____	Once or twice a week_____	Three or more times a week_____

i) Have pain

Not during the past month_____	Less than once a week_____	Once or twice a week_____	Three or more times a week_____

j) Other reason(s), please describe_____
_____

How often during the past month have you had trouble sleeping because of this?

Not during the past month_____	Less than once a week_____	Once or twice a week_____	Three or more times a week_____

6. During the past month, how would you rate your sleep quality overall?
   Very good _____
   Fairly good _____
   Fairly bad _____
   Very bad _____

7. During the past month, how often have you taken medicine to help you sleep (prescribed or "over the counter")?

Not during the past month_____	Less than once a week_____	Once or twice a week_____	Three or more times a week_____

8. During the past month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity?

Not during the past month_____	Less than once a week_____	Once or twice a week_____	Three or more times a week_____

9. During the past month, how much of a problem has it been for you to keep up enough enthusiasm to get things done?
   No problem at all _____
   Only a very slight problem _____
   Somewhat of a problem _____
   A very big problem _____

10. Do you have a bed partner or room mate?
No bed partner or room mate _____
Partner/room mate in other room _____
Partner in same room, but not same bed _____
Partner in same bed _____

If you have a roommate or bed partner, ask him/her how often in the past month you have had . . .

a) Loud snoring

Not during the past month_____	Less than once a week_____	Once or twice a week_____	Three or more times a week_____

b) Long pauses between breaths while asleep

Not during the past month_____	Less than once a week_____	Once or twice a week_____	Three or more times a week_____

c) Legs twitching or jerking while you sleep

Not during the past month_____	Less than once a week_____	Once or twice a week_____	Three or more times a week_____

d) Episodes of disorientation or confusion during sleep

Not during the past month_____	Less than once a week_____	Once or twice a week_____	Three or more times a week_____

e) Other restlessness while you sleep; please describe_____
_____

Not during the past month_____	Less than once a week_____	Once or twice a week_____	Three or more times a week_____

Demographic Information

<u>Your Background</u>

1. What year are you in school?

____ 1st year
____ 2nd year
____ 3rd year
____ 4th year
____ 5th year
____ Other_____

2. Are you a full-time or part-time student?

____ full-time
____ part-time

3. Expected graduation date: _____

4. What is your ethnicity/cultural background (check all that apply)?

____ Hispanic or Latino
____ American Indian/Alaska Native
____ Asian
____ Native Hawaiian or Other Pacific Islander
____ Black or African American
____ White/Caucasian

Other_____

RELATIONSHIP STATUS

Select the option(s) that describe(s) your relationship status. Be sure to check all that apply.

I am presently:
____ Single, living alone or with friends/roommates
____ In a committed relationship, not living with significant other/partner
____ In a committed relationship, living with significant other/partner
____ Married, living with significant other/partner
____ Divorced from significant other/partner
____ Engaged, living with significant other/partner
____ Engaged, not living with significant other/partner

APPENDIX I. PRIMARY STUDY CONSENT FORM

NDSU North Dakota State University
Department of Psychology
232 Minard Hall
Fargo, ND 58108-6050

Title of Research Study: Responses to Challenge II

This study is being conducted by: Dr. Clayton Hilmert, Associate Professor in the Department of Psychology at NDSU (Clayton.Hilmert@ndsu.edu).

Why am I being asked to take part in this research study? You are invited to take part in this research study because you are enrolled in a Psychology class at North Dakota State University. Your participation is entirely your choice, and you may change your mind or quit participating at any time, with no penalty to you.

What is the reason for doing the study? The purpose of this study is to determine how different tasks and circumstances are related to psychophysiological responses**.** At the end of the study, you will be fully informed about the purpose and rationale behind this investigation.

What will I be asked to do? In this experiment, you will have your heart rate and blood pressure assessed using a blood pressure cuff and six electrodes while you perform one or two tasks. You will also be asked to fill out questionnaires to assess what you thought about and how you felt about the experiment.

Where is the study going to take place, and how long will it take? The experiment will take place in Minard 232 C20. After you read the consent form and are willing to participate in this study, you will sign the consent form. Following this you will be performing a task while we monitor your heart rate and blood pressure. The experiment will take about 60 minutes to complete.

What are the risks and discomforts? The risks and discomforts involved in this study are the possible loss of confidentiality. In addition, there is a risk of a minor level of psychological distress due to the ratings of emotions. The psychological stress that may be involved due to these evaluations are not greater than those encountered in daily life. It is not possible to identify all potential risks in research procedures, but the researcher has taken reasonable safeguards to minimize any known risks to the participant**.**

What are the benefits to me? By participating in this study, you may benefit by learning more about how research is conducted. However, you may not get any benefit from being in this study.

What are the benefits to other people? You will help researchers learn more about cardiovascular responses to challenge and help in the advancement of our knowledge of challenge in general.

Do I have to take part in the study? Your participation in this research is your choice. If you decide to participate in the study, you may change your mind and stop participating at any time without penalty or loss of benefits to which you are already entitled. If you choose to withdraw from this study, you will be awarded credit for the time participated in the study.

What are the alternatives to being in this research study? Participation is just one way to gain research credit in your course. See your course syllabus or instructor for descriptions of other ways of gaining extra credit.

Who will see the information that I give? Your responses and consent form will be kept separately. Your responses will be coded with unidentifiable numbers and combined with information from other people taking part in the study. When we write about the study, we will write about the combined information that we have gathered. We may publish the results of the study; however, we will keep your name and other identifying information private.

We will make every effort to prevent anyone who is not on the research team from knowing that you gave us information, or what that information is. For example, your name will be kept separate from your research records and these two things will be stored in different places under lock and key.

Will I receive any compensation for taking part in this study? You will receive four research credits for participating in this research session due to this session lasting approximately 60 minutes. If you choose to withdraw from this study, you will receive research credit points for the time you participated in the study.

What if I have questions?
Before you decide whether to accept this invitation to participate in the research study, please ask any questions that might come to mind. Later, if you have questions about the study, you can contact the researcher, Dr. Clayton Hilmert at 701.231-5148, or Clayton.Hilmert@ndsu.edu.

What are my rights as a research participant?
You have rights as a participant in research. If you have questions about your rights, or complaints about this research [may add, "or to report a research-related injury" if applicable], you may talk to the researcher or contact the NDSU Human Research Protection Program by:

- Telephone: 701.231.8908 or toll-free 1.855.800.6717
- Email: ndsu.irb@ndsu.edu
- Mail: NDSU HRPP Office, NDSU Dept. 4000, PO Box 6050, Fargo, ND 58108-6050.

The role of the Human Research Protection Program is to see that your rights are protected in this research; more information about your rights can be found at: www.ndsu.edu/irb .

Documentation of Informed Consent:
You are freely making a decision whether to be in this research study. Signing this form means that

4. you have read and understood this consent form

5. you have had your questions answered, and
6. you have decided to be in the study.

You will be given a copy of this consent form to keep.

Your signature	Date
Your printed name	
Signature of researcher explaining study	Date
Printed name of researcher explaining study	

APPENDIX J. PRIMARY STUDY EXPERIMENTAL PROTOCOL

Materials:

1. Consent form
2. Video Camera
3. Finapress Medical System, Impedance Cardiography (ICG), and Electrocardiogram (EKG)
4. Stopwatch
5. Clipboards
6. 3 Pens
7. Questionnaires
8. Six Electrodes

Personnel involved: experimenter (1), audience member and hook up (3)

AT LEAST 24 HOURS BEFORE EXPERIMENT SESSION

Contact participant to remind them they have an experiment session at _____ o'clock the next day in Room 232C20 of the Minard Hall (give directions if necessary). Inform the participant that the experiment includes some physiological recording measures which require that six "sticker-like" electrodes be attached on their shoulder blade, back, and stomach, so they should wear a loose fitting shirt (and a sports bra for females). Remind the participant that she should refrain from caffeine consumption, extreme exercise, full meal, and cigarette smoking at least four hours prior to the experiment. Ask if the participant understands and wait for a verbal agreement.

Answer any questions.

WELCOME

HOOK UP - Before the arrival of the participant, have the electrodes ready.

When the participant arrives, greet her and ask if she needs to use the restroom or to spit out any gum. Remind the participant to switch off her cellphone and keep it away for the duration of the experiment. Show the participant where to sit and explain:

HOOK UP: "Thank you for coming in to do our experiment. In this experiment we are interested in how a person's blood pressure, heart rate, and nervous system change during a challenging task. Therefore, I am going to take measures of each of these things before, during, and after you perform certain tasks. This is what I will take your blood pressure with (SHOW BP CUFF). This cuff here goes around the middle

finger of your non-dominant hand. The cuff will automatically take readings and will feel a little snug when it does, but it is not painful. (SHOW Electrodes) Six of these electrodes will be placed (POINT TO LOCATIONS) on the front and back of your neck, your shoulder blade here, the bottom of your rib cage here, your lower back, and above your hip here. These will measure your heart rate and other cardiovascular functions.
Do you have any questions about anything I've said so far?"

CONSENT FORM

HOOK UP: "All of the data gathered here today including physiological measures and any questions you answer will be kept strictly confidential. No one outside this lab will ever be able to match up your name with the data. Also, I must inform you that you can discontinue the experiment at any time without penalty. This consent form basically says everything I just explained. Please read it over carefully and let me know if you have any questions.

ANSWER ANY QUESTIONS TO THE BEST OF YOUR ABILITY.

HOOK UP: Are you ready to begin?"

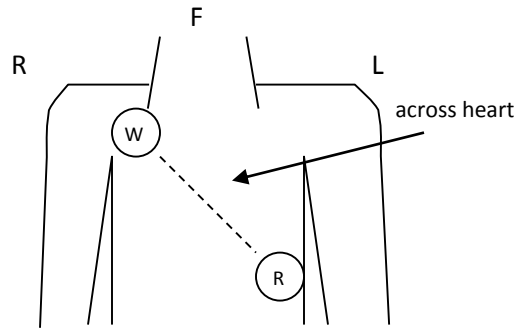
AFTER THE PARTICIPANT SAYS YES…

ELECTRODE PLACEMENT

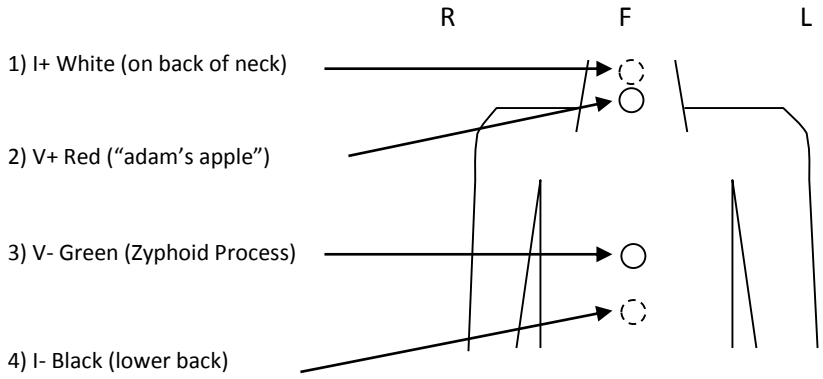
HOOK UP: "Alright. First, I am going to start attaching the electrodes."

BEGIN HOOKING PARTICIPANT UP TO BP, ECG, and ICG.

HOOK UP ELECTRODES TO PARTICIPANT



Leave the black lead unattached, this ground is unnecessary when also recording impedance.



AFTER ALL ELECTRODES ARE ATTACHED, MEASURE THE DISTANCE BETWEEN ELECTRODES (between the Red and Green electrodes, and between the White and Black electrodes) AND RECORD IT. HELP THE P SIT SO THAT THE LEADS ARE AS UNOBTRUSIVE AS POSSIBLE USING THE CLOTHING CLIPS.

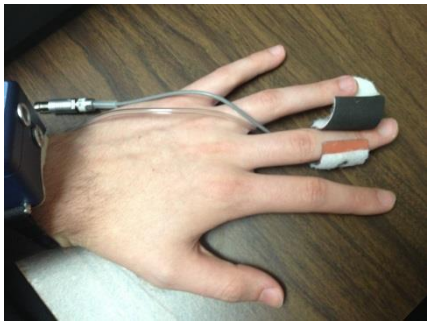
SET UP THE *ACQKNOWLEDGE* PROGRAM ON THE COMPUTER.

HOOK UP LEAVES THE ROOM. EXPERIMENTER (E) ENTERS THE ROOM.

E: “Hi, I’m the experimenter of this experimenter. I am going to attach blood pressure cuffs on you. Which hand do you write with? Alright, can I please have you put your other arm on the table so I can fit your middle finger with the blood pressure cuff? It’s very important that you don’t move this arm while we are taking your blood pressure. So please keep it on the table and still for the duration of the experiment. I’m going to start the apparatus.”

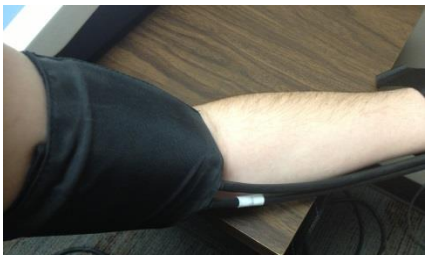
Securely wrap the finger cuff around the middle finger above the main joint.

- Make sure the participant's finger is not uncomfortable.



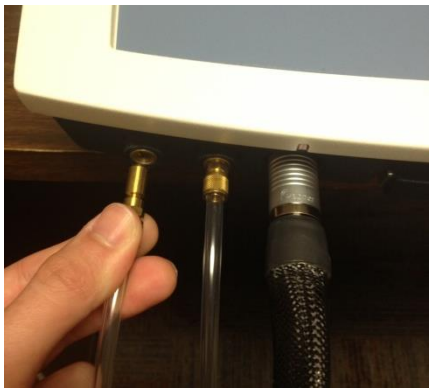
Connect the tube and wire of the finger cuff to the frontend unit, with the clear tube being connected to the lower opening and the wire above that (with the red dot facing up).

Wrap the arm cuff around the left bicep, ensuring that the black tubes run along the part of the arm closest to the body.



Insert the ends of the clear tubes of the arm cuff into the openings on the front left side of the Finometer.

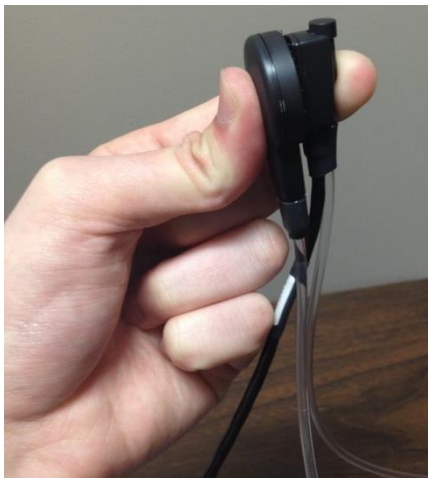
- There should be a click when each tube is connected properly.



Insert the electrical connector of the height correction unit into the telephone chassis at rear of the frontend unit.

- There should be a click when the wire is connected properly.

Null the height correction unit by holding both sensors together in the air, and then press the "mark" button on the Finometer.

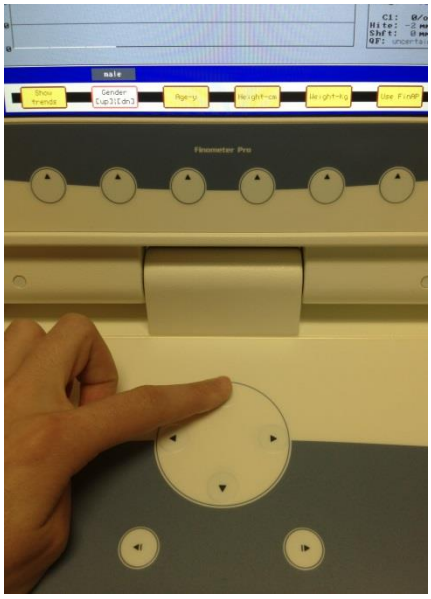


Place the circular sensor on the arm cuff at mid-level, lining up with the participants heart.

Place the other sensor on the finger cuff.

Click the physical button directly below “Finometer clinique” on the screen twice.

Using the directional pad on the base of the Finometer and the backward and forward buttons, enter the participant's correct gender and age.



Press the "start/stop" button to begin a measurement.

Take a calibration.

Click "mark" during measurements to create a time stamp.

HR/BP BASELINE 1 (10 MINUTES)

"√" IN THE MARGIN MEANS THE FINAPRESS AND COMPUTER CLICKER SHOULD BE CLICKED.

WHEN EVERYTHING LOOKS LIKE IT'S WORKING…

E: "The next thing I need you to do is to sit as STILL as possible and to RELAX. Basically, I just want you to get used to where you are and to having the cuff on your finger. It's important that you do not move the arm from which your blood pressure is being taken. You will feel the cuff start to get a little snug and your finger might change color a little bit. However, I would like to assure you that this is fine. Do you have any questions?"

ANSWER QUESTIONS TO THE BEST OF YOUR ABILITY.

√ E: "Alright, please try not to move your arm and I'll be back in 10 minutes."

THE E LEAVES FOR BASELINE, START STOPWATCH.

√ AFTER 10 MIN THE E RETURNS

QUESTIONNAIRE #1

E: "Next, I need you to please fill out a couple of questionnaires.
Here is the first one. There are **no right or wrong answers** to the questions in this packet, just what is **true for you**. Please answer as **honestly** as possible. I will be back in a few minutes with the next one.

GIVE THE SPEECH TOPIC ASSESSMENT

AFTER 2 MINUTES
E: "Are you finished with that packet?"

WHEN THE PARTICIPANT IS FINISHED

E: "Okay, let me get that out of the way. Here is the second packet. Again, there are no right or wrong answers to the questions in this packet, just what is true for you. I'll be back so we can move on in a few minutes."

DURING THIS TIME THE SPEECH TOPIC ASSESSMENT IS USED TO PREPARE THE SPEECH TOPIC CONDITION MANIPULATION.

(LOW ENGAGEMENT CONDITION): BASED ON THE RATINGS ON THE SPEECH TOPICS, THE TOPIC WITH THE LOWEST RATINGS WILL BE THE PARTICIPANT'S SPEECH TOPIC.

(HIGH ENGAGEMENT CONDITION): BASED ON THE RATINGS ON THE SPEECH TOPICS, THE TOPIC WITH THE HIGHEST RATINGS WILL BE THE PARTICIPANT'S SPEECH TOPIC.

THEREFORE THE E PUTS THE 6 CARDS WITH THE SPEECH TOPIC IN THE 'LUCKY DRAW' BOX. THE SIDE WITH THE SPEECH TOPIC FACES DOWN.

AFTER 3 MINS, THE E RETURNS WITH THE BOX AND COLLECTS THE QUESTIONNAIRE.

SPEECH TASK INSTRUCTIONS (5 MINS)

E: "Before you perform the task here today I need to read you this disclosure of information:

READ FROM A CARD: The tasks you are about to do are designed to assess certain **psychological and social capabilities**. Research has shown that abilities including **verbal intelligence**, **coherence**, **poise**, and overall performance on these tasks are predictive of how

successful a person will be in their relationships and occupation, whatever that may be. That is, there is no right or wrong way to perform these tasks, but how you perform on will be related to how **happy** you will be in your relationships and how **successful** you will be at work in the future.

"Do you have any questions about this?

"The task you are going to do is a standardized **public speech task.** Your speech topic is assigned randomly. In this box we have **6 cards**, each of which has **a particular speech topic**. I will ask you to draw **one** of them and **that will be your speech topic**."

THE PARTICIPANT PICKS ONE NOTE. THE E TAKES THE NOTE FROM HER.

E: "Okay, your speech topic is on _____. [SHOW HER THE NOTE] For **five** minutes you will talk about this topic. It's important that you express yourself clearly. Exactly what you say and how you say it is completely up to you. You will have **5 minutes** to think about what you want to say in your speech. Then you will give a 5-minute speech. It is very important that you **speak for the entire 5 minutes**."

NOT READING...

E: "Because how you perform these tasks depends not only on what you say, but **how** you say it, we will have two **trained evaluators** observe you during your speech. These assistants will act as your audience and they will **evaluate** you. After you finish the speech they will answer questions about your **performance** and tell us about their **impressions** of you.

WALK TO VIDEO CAMERA...

"Additionally, we will be videotaping your performance so that additional **experts** in self-presentation, public speaking, and psychological well-being can watch the videos and make assessments of your **verbal intelligence, the organization and effectiveness** of your arguments, as well as your **vocabulary and knowledge** of the issue. The experts will also evaluate your **poise, articulation, style, and communication skill**. Do you have any questions about what I've said?"

ANSWER ANY QUESTIONS.

DO NOT PROVIDE THEM WITH PEN AND PAPER.

E: "Okay, you now have **5 minutes** to plan your speech. I'll leave you to think about it and I will return in 5 minutes."

√ E LEAVES.
√ AFTER 5 MINS E RETURNS WITH 2 AUDIENCE MEMBERS

PREPARE THE AUDIENCE CLIPBOARDS AS THE E SAYS...

E (to the participant): "Okay, 5 minutes has passed and your preparation period is over. Do you have any questions?"

ANSWER ANY QUESTIONS

E (to the participant): "This is your audience. Their job is to **observe and evaluate** the performance that you are about give. It is important that you speak for the **entire 5 minutes**. After the task is completed they will answer **some questionnaires about your performance and their impressions of you in the other room**."

E GETS THE VIDEO CAMERA READY.

AUDIENCE MEMBERs READ THE INSTRUCTIONS AND LOOK UP AT THE E.

E: (To audience members) "Okay, do you have any questions before we begin?"
(To participant) "Do you have any questions?"

ANSWER ANY QUESTIONS

E: "Okay, then after I start the video camera I will tell you to begin your speech. Remember it's very important that you continue speaking for the entire five minutes."

E STARTS THE VIDEO CAMERA AND STANDS NEXT TO THE FOLDING PANEL AND THE AUDIENCE MEMBERS.

√ E: "Please begin your speech."

WHILE P GIVES SPEECH, E APPEARS TO BE TAKING NOTES.

AT 3:30 E SAYS ONE OF THE FOLLOWING IN A NON-SUPPORTIVE TONE...

It's important that you speak for the entire 5 minutes.
Talk about some different qualities or characteristics.
You're spending too much time on this, move on.
You have to keep an eye contact with the audience members.

<u>SOCIAL SUPPORT CONDITION</u>

AUDIENCE MEMBERS

- 0:00 – 0:30
  - Slight interest – sitting up in chair but leaning on the backrest
  - Eye contact
  - Neutral facial expression
- 0:30 – 1:00

    - Start to smile
    - Begin slow nods
    - Start to lean forward
- 1:00 – 1:30
    - Nodding
    - Smiling
    - Say something appropriate
- 1:30 – 2:00
    - SUBTLE nodding
    - Smiling
    - Leaning forward
- 2:00 – 2:30
    - Nodding
    - Smiling
    - Leaning forward
    - Say something appropriate
- 2:30 – 3:00
    - Nodding
    - Smiling
    - Leaning forward
- 3:00 – 3:30
    - Nodding
    - Smiling
    - Leaning forward
    - Say something appropriate
- 3:30 – 4:00
    - Nodding
    - Smiling
    - Leaning forward
- 4:00 – 4:30
    - Continued interest
    - Say something appropriate
- 4:30 – 5:00
    - Continued interest
    - "Wow! That was tough. You did great!"

Possible comments to make:

- "Oh! I never thought of that."
- "Absolutely!"
- "Good point!"
- "Definitely!"
- "Yeah"
- "You're doing great!"

NO SUPPORT CONDITION

AUDIENCE MEMBERS

- 0:00 – 0:30
  - Neutral expression
  - Lean back in chair, but sit up straight
- 0:30 – 1:00
  - Continued expression
- 1:00 – 1:30
  - Look over their head or off to the side of their head
  - Shift SLIGHTLY in chair
- 1:30 – 2:00
  - Look over their head or off to the side of their head
  - SUBTLY look at your watch (or nails if you don't have a watch)
- 2:00 – 2:30
  - Look over their head or off to the side of their head
- 2:30 – 3:00
  - SUBTLY look around room
  - Then look over their head or off to the side of their head
- 3:00 – 3:30
  - SLIGHTLY shift in seat
  - Small sigh
- 3:30 – 4:00
  - Look over their head or off to the side of their head
  - Look bored
- 4:00 – 4:30
  - SUBTLY look at your watch (or nail)
  - Look over their head or off to the side of their head
- 4:30 – 5:00
  - Look bored

√ AFTER 5 MIN

E: (to audience members) "The task has ended. Thank you for your assistance. I have the questionnaires for you to fill out next door."

QUESTIONNAIRE #2

E: (To Participant) "Please fill out this questionnaire."
STAY IN THE ROOM. WHEN P IS FINISHED WITH QUESTIONNAIRE.

HR/BP BASELINE 2 (8 MINUTES)

E: "The next thing I need you to do is to sit as STILL as possible while we take another 8 minute measure. It's important that you do not move the arm from which your blood pressure is being taken. Do you have any questions?"

ANSWER QUESTIONS TO THE BEST OF YOUR ABILITY.

√ E: "Alright, please try not to move your arm and I'll be back in 8 minutes."

THE E LEAVES FOR BASELINE, START STOPWATCH.

√ AFTER 8 MIN THE E RETURNS

UNHOOK THE PARTICIPANT

POST TASK QUESTIONNAIRES

GIVE POSTTASK QUESTIONNAIRES

E: "Please fill out this questionnaire."

DEBRIEF

E: "So now we are finished. I would like you to agree not to reveal any info to anyone as it will confound the experiment."

WAIT FOR PARTICIPANT TO SAY "OKAY".

E: "Thank you very much. I'd like to give you some more information about the study you just took part in."

READ:

Thank you for participating in our study.

When people are under stress, they undergo several important physiological changes that help prepare them to deal with the stressful situation. For instance, blood pressure, heart rate and hormone levels may all be affected. Some studies indicate that social support that a person perceives when they are in a stressful situation has an impact on the physiological changes they experience. In this experiment, we are looking at the effects of social support, to see how they affect blood pressure, heart rate, and autonomic nervous system activity. Although the ability to speak in public may be related to future success, we asked you to do the public speaking task in order to simulate a stressful experience while your audience responded to you as we instructed her to. The reason for videotaping participants in the speech task is mainly to induce stressfulness. Therefore we will not send the recording of your speech to experts for evaluation.

In fact, the video camera had no video cassette in it, which means we do not keep any recording of your speech [SHOW HER THAT THE VIDEO CAMERA HAS NO VIDEO CASSETTEE IN IT]. We put you through these challenging tasks so that we can see how your body responds to stress. Specifically, we are interested in how your heart rate and blood pressure are affected during the experience. We also asked you to fill out questionnaires to gain insight into your emotional states.

Are there any questions?

Before we are finished I just need to ask **you to please not tell anyone about any of the details regarding this experiment.**

WAIT FOR A VERBAL AGREEMENT

Your research credit will be automatically transferred to you 24 hours from now.

Thanks for your participation.

GIVE CREDIT, THANK, AND EXCUSE THE PARTICIPANT.