Abstract

Excessive stress reactivity, particularly excessive blood pressure reactivity, to social-evaluative stress is associated with poor mental and physical health outcomes. Compassion-based interventions have demonstrated the ability to buffer against physiological and subjective stress reactivity. However, extant studies have predominantly implemented interventions requiring an intensive time commitment, limiting intervention accessibility, and no studies have measured blood pressure reactivity as a compassion-based intervention outcome. To address these gaps in the literature, this study recruited undergraduate students (n = 50), who were cluster randomized to participate in one of two possible brief (40 min), group-based interventions: (1) compassion training, or (2) an active control intervention which taught participants a skill from cognitive behavioral therapy (i.e., cognitive reappraisal). After the intervention, participants immediately underwent an acute social-evaluative stressor, the Trier Social Stress Test for Groups (TSST-G). State compassion for others, state self-compassion, systolic blood pressure (SBP), diastolic blood pressure (DBP), heart rate (HR), and subjective stress were measured before and after the intervention to evaluate pre- to post-intervention effects. Physiological and subjective stress were also measured before, during, and after the TSST-G to evaluate stress-buffering effects of the interventions. Linear mixed models were used to examine both immediate intervention effects and stress-buffering effects. Results indicated that the brief, group-based compassion intervention demonstrated pre- to post-intervention increases in state compassion for other and decreases in SBP compared to the active control intervention, while both interventions demonstrated immediate increases in self-compassion and reductions in HR. The compassion intervention also demonstrated reduced DBP reactivity to the TSST-G compared to the control intervention. These results indicate that brief compassion training may be a promising

intervention that demonstrates positive pre- to post-intervention effects and stress-buffering effects for young adults experiencing acute social-evaluative stress. These results provide impetus for incorporating compassion training in settings which serve young adults, such as college counseling centers.

Keywords: compassion, self-compassion, blood pressure, stress reactivity, young adults

EFFECTS OF A BRIEF GROUP-BASED COMPASSION INTERVENTION ON PHYSIOLOGICAL AND SUBJECTIVE STRESS REACTIVITY

by

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Introduction

High stress burdens are well-known contributors to physical and mental health conditions, including cardiovascular disease, depression, and anxiety (Chrousos, 2009; Dimsdale, 2008; Heim et al., 2008; Shields & Slavich, 2017). Stress-related health concerns involve an interplay between psychological and physiological processes, and repeated exposure to stress can disrupt both types of processes. Psychologically, research has demonstrated that cumulative stress exposure can influence an individual's beliefs about the world (e.g., the world is a dangerous place) and how they relate to themselves (Heinonen et al., 2018; Kendall-Tackett, 2002; Wright et al., 2009). Biologically, high stress burdens contribute to allostatic load, or "wear and tear" on the body's systems (McEwen & Karatsoreos, 2015). One of the ways in which allostatic load disrupts physiology is through changes in the way individual responds to stress. Targeting stress-related processes through interventions (e.g., contemplative interventions, cognitive behavioral therapy [CBT] interventions; Kazantzis et al., 2018; Morton et al., 2020; Santos et al., 2021) that improve coping resources (e.g., compassion, cognitive reappraisal) represents one approach that may improve stress-related health concerns.

Contact with an acute stressor (e.g., being confronted by a wild animal, attending a job interview) paired with the perception of the stressor as a threat triggers the body's sympathetic-adrenal-medullary (SAM) system, which is responsible for what is known as the "fight or flight" response (Godoy et al., 2018). This response activates the sympathetic branch of the autonomic nervous system, which triggers the release of epinephrine, and the body prepares for the perceived threat with increased heart rate and blood pressure (Goldstein, 2010). The SAM system and associated reactions are responsible for the body's rapid stress response, which happens immediately after contact with an acute stressor (Godoy et al., 2018). In contrast, the

body's slower stress response is regulated by the hypothalamic-pituitary-adrenal (HPA) axis. The activation of the HPA axis sets off a cascade of reactions that culminate in the release of cortisol 20 to 30 minutes after the onset of an acute stressor (Foley & Kirschbaum, 2010).

A substantial portion of stress literature is focused on measuring indicators of the SAM system and the HPA axis after exposing participants to an acute stressor, with the goal to understand how differences in stress responding relate to physical and mental health. This area of research is focused on abnormal patterns of stress responses underlying health concerns and how these patterns may be targeted for intervention to improve health, however; few studies have examined the effects of interventions, particularly brief interventions, on physiological stress reactivity. Examining how a brief intervention may influence participants' stress responses is the purpose of the present study.

Stress Reactivity

Stress reactivity refers to an individual's response to stress, and can be assessed through physiological, behavioral, or subjective measurement and/or through cognitive function (Schlotz, 2013). Numerous studies have demonstrated that abnormal stress reactivity to acute stress is a transdiagnostic mechanism underlying cardiovascular disease (e.g., hypertension; Chida & Steptoe, 2010; Turner et al., 2020) and mental health concerns (Zorn et al., 2017). Because stress reactivity, by definition, is a *response* to stress, most studies examine stress reactivity using stressful tasks developed to induce stress for experimental investigation.

The Trier Social Stress Test (TSST; Kirschbaum et al., 1993) is considered the gold standard in stress induction research (Allen et al., 2014). The TSST consists of three parts: (a) preparing for a speech, during which participants are provided a speech prompt to consider why they are a good candidate for their ideal job; (b) performing the speech; and (c) performing a

mental arithmetic task, during which participants must subtract a two-digit number starting at a four-digit number (e.g., serially subtracting 13 starting at 1024; Kirschbaum et al., 1993). To begin the task, participants are seated before a panel of two experimenters (i.e., TSST panel) posing as experts in speech and nonverbal behavior who will evaluate the participant's performance. The panelists wear white lab coats and maintain neutral affect throughout the TSST to avoid providing participants with positive nonverbal feedback, which heightens the unpredictability of the task. Aspects of unpredictability and social evaluation are considered the reasons why the TSST is effective at inducing stress (Dickerson & Kemeny, 2004). Since the creation of the original protocol, the TSST has been validated in group contexts and for youth (von Dawans et al., 2011; Yim et al., 2015).

In the vast TSST literature base, both physiological and self-report measures of stress reactivity have been widely implemented (Allen et al., 2016; Morton et al., 2020). Many of these studies use ANS measures, such as heart rate, blood pressure, and heart rate variability, and HPA axis measures such as cortisol and salivary alpha-amylase. While many studies have induced stress via the TSST, fewer have examined the effects of interventions on stress reactivity, and even fewer have examined the effects of interventions on blood pressure reactivity (Morton et al., 2020). The next section discusses how blood pressure reactivity is a particularly important indicator for health outcomes.

Blood Pressure Reactivity

Blood pressure reactivity is the change in blood pressure from a resting baseline measurement to a peak measurement during a stressor (Matthews et al., 2004). High blood pressure reactivity to acute stressors has been demonstrated as an indicator for future health problems (Carroll et al., 2001, 2011; Matthews et al., 2004, 2006; Zhao et al., 2015). For

example, longitudinal studies have demonstrated that those who have higher blood pressure reactivity when faced with acute stress are more likely to develop cardiovascular disease such as hypertension later on in life (Carroll et al., 2001, 2011; Matthews et al., 2004, 2006; Zhao et al., 2015). Another study, the Coronary Artery Risk Development in Young Adults (CARDIA), followed participants beginning in young adulthood (ages 18 to 30) and throughout their lives. Higher blood pressure reactivity to various psychological stressors in young adulthood predicted the development of hypertension in later adulthood. The higher the participant's blood pressure reactivity was as young adults, the earlier they developed hypertension later in life (Matthews et al., 2004).

Two additional large, long-term blood pressure reactivity studies demonstrated similar results to the CARDIA study. A 10-year longitudinal study indicated that systolic blood pressure (SBP) reactivity to mental stress was a significant predictor of resting SBP levels later in life (Carroll et al., 2001). A 12-year follow-up study indicated that SBP reactivity was again a predictor of future resting SBP levels and more upward drift of SBP over time (Carroll et al., 2011). Interestingly, for both studies, earlier in life blood pressure was less predictive of future blood pressure related health problems (e.g., hypertension) than one's blood pressure reactivity, suggesting that reactivity is a critical indicator of long-term health.

While there are numerous studies indicating heighted blood pressure reactivity may be problematic for future cardiovascular outcomes, there does not appear to be consensus on the magnitude of response that constitutes heightened reactivity to the TSST. However, studies often cite a 20 mmHg and 15 mmHg increases in SBP and DBP, respectively, to the cold pressor test to distinguish hyperreactors from normoreactors (Harlan et al., 1964; Hines, 1940; Kunrath et al., 2013). The cold pressor test is a laboratory-based stress test for which participants are asked to

submerge their hands in ice water (Hines & Brown, 1936). Despite a lack of consensus for what constitutes a hyperreactor for other laboratory-based stress tests, some studies term those with the largest changes in blood pressors as "hyperreactors, and compare them to those with the smallest change in blood pressure (e.g., comparing the lowest and highest quartiles in a given sample); these studies have found that hyperreactors are at highest risk for adverse health outcomes (Brindle et al., 2016; Kupper et al., 2021; Radtke et al., 2013; Steptoe et al., 2016; Zhao et al., 2015). For instance, one study examined quartiles of blood pressure reactivity to the cold pressor test and found that those in the highest quartile for increase in SBP (≥19.3 mmHg increase), relative to those in the lowest quartile (<6.7 mmHg increase), were 1.45 times and 1.79 times as likely to report hypertension and stage 2 hypertension, respectively, at a seven-year follow-up; these results were found after controlling for other risk factors such as cigarette smoking, alcohol consumption, and physical activity (Zhao et al., 2015). The same study found that those in the highest quartile for increase DBP (≥11.3 mmHg) relative to those in the lowest quartile (<3.3 mmHg increase), were 1.75 times and 1.82 times as likely to report hypertension and stage 2 hypertension, respectively (Zhao et al., 2015).

In summary, heightened stress reactivity, and especially heightened blood pressure reactivity, contribute to many poor health outcomes. However, few studies have examined whether blood pressure reactivity may be responsive to brief interventions as a way to improve health. Further, studies indicate that heightened stress reactivity during emerging adulthood may be particularly predictive of later health outcomes. Moreover, young adults in college tend to have many stressors leading to mental health (Hunt & Eisenberg, 2010). Thus, the next section discusses the importance of understanding stress reactivity in young adults.

Health and Stress Reactivity in Emerging Adulthood

Emerging adulthood is a distinct developmental period between adolescence and adulthood characterized by life transitions, and identity exploration and solidification (Arnett, 2000, 2007). The typical age range included for emerging adulthood is 18–29 years old, during which young adults experience instability across numerous aspects of life, including changes in friendships, romantic relationships, education, and/or employment (Arnett et al., 2014; Lapierre & Poulin, 2022; Matud et al., 2020).

The period of emerging adulthood includes additional stressors due to new life experiences (e.g., college, job, moving) which are associated with mental health consequences among young adults (Arnett et al., 2014; Lapierre & Poulin, 2022). Compared to other age groups, young adults report higher stress and more mental health concerns, including elevated depression and anxiety symptoms (APA, 2020; R. D. Goodwin et al., 2020; Sutin et al., 2013). Among college students specifically, college counseling centers report depression and anxiety as predominant presenting concerns (Pérez-Rojas et al., 2017; Xiao et al., 2017), and the demand for mental health services for college students continues to increase (Xiao et al., 2017).

Beyond mental health concerns, emerging adulthood is also an important period for preventing cardiovascular disease (Vale, 2000). While young adults report much lower risk of cardiovascular disease compared to older age groups (Rodgers et al., 2019), cardiovascular disease is rising in this population (M. G. George et al., 2017). Further, most cardiovascular disease develops over the life course, with some conditions (e.g., atherosclerosis) beginning in childhood (Gooding et al., 2020). As cardiovascular disease often develops over many years, experts recommend strategies, such smoking cessation and exercise, during emerging adulthood as early preventative measures (Gooding et al., 2020). Several longitudinal studies assessing

stress reactivity during emerging adulthood have demonstrated that those who report high stress reactivity have increased risk of adverse cardiovascular outcomes (e.g., hypertension, coronary artery calcification) later in life (Carroll et al., 2001, 2011; Matthews et al., 2004, 2006). These studies indicate the need to identify strategies that mitigate stress reactivity during emerging adulthood as a preventative cardiovascular health measure.

Stress reactivity in young adults is a transdiagnostic factor which predicts both mental and physical health concerns; thus, interventions that can buffer stress reactivity in this population may effectively interrupt the progression of both mental and physical health concerns. Practices targeting the cultivation of compassion, (e.g., guided compassion meditations) have demonstrated positive effects on both physiological and self-report measures of stress reactivity (Arch et al., 2014). Before examining the research behind these practices, the next section will define and discuss the distinct features of compassion.

Compassion

Compassion has garnered numerous definitions over the many decades of philosophical and psychological research. An early definition in the psychology literature was from Richard Lazarus' work on emotion: "being moved by another's suffering and wanting to help" (Lazarus, 1991, p. 289). Subsequent definitions of compassion are similar, including those from Gilbert (2009): "A deep awareness of the suffering of another coupled with the wish to relieve it" (p. 13); and Feldman and Kuyken (2011): "An orientation of mind that recognises pain and the universality of pain in human experience and the capacity to meet that pain with kindness, empathy, equanimity, and patience" (p. 145). These definitions, along with several others, were included in a recent review of extant definitions and measures of compassion to build consensus in the field and provide recommendations for measuring compassion (Strauss et al., 2016). As a

part of this review, eight prominent definitions of compassion were analyzed to identify core components of this construct. Strauss et al. (2016) put forth an encompassing five-component definition of compassion that includes: (a) recognizing suffering, (b) understanding that suffering is a universal aspect of being human, (c) empathizing with the person who is suffering, (d) being able to tolerate discomfort that comes from connecting with suffering, and (e) having motivation to and/or acting to relieve suffering.

Most definitions of compassion include the assumption that compassion comes from oneself and is directed toward others. In fact, among the definitions reviewed by Strauss et al. (2016), five out of eight referenced "another's" or "other's" suffering. A special case of compassion that has garnered considerable scientific inquiry in the past two decades is the application of compassion towards the self, often referred to as self-compassion (Neff, 2003). All five components of Strauss et al.'s (2016) definition, when directed toward oneself, reflect self-compassion. Throughout the rest of the document, I specify "compassion" when discussing the construct broadly, including both compassion for others and self-compassion; "self-compassion" when discussing research focused on compassion for the self; and "compassion for others" when discussing research focused on compassion for others.

Trait Compassion

Both compassion for others and self-compassion have amassed a wealth of evidence that these constructs are related to health and stress reactivity. In this section, I first discuss evidence that trait compassion for others and trait self-compassion are associated with health and stress reactivity, and then synthesize research on compassion-based contemplative interventions and their effects on health and stress reactivity.

Trait Compassion and Health

Several studies have examined how trait compassion is associated with health outcomes. Two recent prospective studies examined how trait compassion for others was related to affective and cognitive well-being, positive and negative affect, and stress-related measures (Saarinen et al., 2020; Saarinen et al., 2021). One study examined compassion for others and measures related to stress, including vital exhaustion and negative emotionality (Saarinen et al., 2021). Vital exhaustion was measured as an indicator of chronically high levels of stress and negative emotionality was measured as an indicator of susceptibility to acute stressors. Researchers found that higher compassion for others predicted lower vital exhaustion and lower negative emotionality (Saarinen et al., 2021). In another study using the same longitudinal dataset, Saarinen et al. (2020) found that found that compassion for others significantly predicted overall affective well-being and social support 10 and 15 years later, respectively (Saarinen et al., 2020). Similarly, another longitudinal study examining trait compassion for others found that higher compassion for others predicted better physical and mental well-being, and lower levels of loneliness at five years later (Lee et al., 2021). This study also found that trait self-compassion was similarly associated with later mental and physical well-being (Lee et al., 2021).

Relative to trait compassion for others, trait self-compassion has garnered considerably more evidence that it is associated with health and well-being, with numerous meta-analytic syntheses conducted in this area (Ewert et al., 2021; Helminen et al., 2022; MacBeth & Gumley, 2012; Marsh et al., 2018; Phillips & Hine, 2021; Zessin et al., 2015). One meta-analysis was conducted to examine associations between trait self-compassion and measures of psychopathology, and researchers found that self-compassion was significantly negatively associated with depression, anxiety, and stress across 20 adult samples (N = 4,007; MacBeth &

Gumley, 2012). A similar meta-analysis was conducted with 19 adolescent samples (N = 7,132) and found that self-compassion was significantly negatively associated with depression (r = -0.52, $p < 0.001$), anxiety (r = -0.49, $p < 0.001$), and stress (r = -0.56, $p < 0.001$; Marsh et al., 2018). In examining self-compassion and well-being, another meta-analysis (N = 16,416) found that self-compassion is positively associated with cognitive well-being (r = 0.47, $p < 0.01$), positive affective well-being (r = 0.39, $p < 0.01$), and psychological well-being (r = 0.62, $p < 0.01$), and negatively associated with negative affective well-being (r = -0.47, $p < 0.01$; Zessin et al., 2015).

Reviews of trait self-compassion have also examined how this construct is associated with purported mechanisms underlying health and well-being, including self-efficacy and coping abilities (Ewert et al., 2021; Liao et al., 2021). Meta-analyses have found that self-compassion is positively associated with self-efficacy (r = 0.35, $p < 0.001$) and adaptive coping (e.g., problem-focused coping, planning, acceptance; r = 0.31, $p < 0.001$), and negatively associated with maladaptive coping (e.g., substance use, distraction, self-blame; r = -0.51, $p < 0.001$; Ewert et al., 2021; Liao et al., 2021). Studies have also examined how trait self-compassion relates to mechanisms contributing to negative mental and physical health outcomes; namely, stress reactivity, which I discuss in the next section.

Trait Compassion and Stress Reactivity

Most studies examining associations between trait compassion and stress reactivity have focused on trait self-compassion. However, one study examined whether trait compassion for others was stress-buffering during a social-evaluative stress test (Cosley et al., 2010). Participants were asked to perform a speech and a mental arithmetic task in front of two experimenters. Participants were randomized to a neutral condition in which experimenters

showed no affect, or a social support condition in which the experimenters gave positive feedback. In the neutral condition, those who reported high levels of compassion for others exhibited no differences in blood pressure, cortisol, or heart rate variability to the stress test relative to those who reported low levels of compassion. However, in the social support condition, those who reported high levels of compassion for others exhibited reduced stress reactivity across all physiological variables relative to those who reported low levels of compassion. Results from this study indicated that those with high levels of compassion for others may be able to receive social support more effectively to buffer against stress reactivity (Cosley et al., 2010).

Similar to the research base on trait compassion and health, there is considerably more trait self-compassion research than research on compassion for others. One recent study examined whether trait self-compassion was associated with a cross-sectional self-report measure of stress reactivity (Helminen, Scheer, et al., 2021). This study found that self-compassion was negatively associated with stress reactivity among young adults, even after controlling for state stress levels and another coping resource that exhibits stress-buffering effects, trait mindfulness (Helminen, Scheer, et al., 2021). However, this study was limited examining cross-sectional associations using self-report measures.

Researchers in this area often implement laboratory-based stress induction designs (e.g., TSST) instead of cross-sectional self-report measures to examine whether trait self-compassion predicts induced stress reactivity (Breines et al., 2014, 2015; Ceccarelli et al., 2019; Ewert et al., 2018; Luo et al., 2018). Among stress induction studies, researchers have demonstrated stress-buffering effects of trait self-compassion on self-report stress reactivity variables, including negative affect, maladaptive thoughts (e.g., “I’m a loser”), perceived stress, and shame

(Ceccarelli et al., 2019; Ewert et al., 2018; Luo et al., 2018). Among these studies, trait self-compassion has also demonstrated stress-buffering effects on physiological stress reactivity variables, including cortisol, salivary alpha-amylase, and heart rate variability (Breines et al., 2014, 2015; Ceccarelli et al., 2019; Luo et al., 2018). Table 1 summarizes the extant studies examining the effects of trait compassion on stress reactivity.

Taken together, extant studies of trait compassion for others and trait self-compassion highlight the considerable evidence that these constructs are associated with health, well-being, and stress reactivity. However, research examining trait compassion limits conclusions that may be drawn about whether compassion for others and self-compassion are key drivers of health and well-being, as these studies do not experimentally induce self-compassion or compassion for others to understand whether practicing compassion leads to positive health and well-being. For example, it could be that people who are more compassionate do not react to stress as intensely, or that people who do not get as stressed have greater capacity to be compassionate, or a bi-directional combination. Intervention research in which participants explicitly cultivate their self-compassion and compassion for others in comparison to a control intervention is needed to determine causality. In the next section, I describe the research on compassion-based contemplative interventions and discuss how these interventions may influence health, well-being, and stress reactivity.

Compassion-Based Contemplative Interventions

Common contemplative interventions such as Mindfulness-Based Stress Reduction (MBSR; Kabat-Zinn, 1990) and Mindfulness-Based Cognitive Therapy (MBCT; Segal et al., 2002) include lessons teaching compassion-based contemplative practices, and have demonstrated that they have the ability to increase self-compassion (Frostadottir & Dorjee, 2019;

Birnie et al., 2010). However, one of the issues in contemplative science research is that researchers cannot be sure of the "active ingredients" of the interventions that confer positive outcomes because the interventions are comprised of several types of contemplative practices (e.g., mindfulness, yoga, and self-compassion all included in MBSR). Recently developed contemplative interventions have become more focused, and several interventions have focused specifically on compassion-based contemplative practices, such as Compassion Cultivation Training (CCT; Jazaieri et al., 2014) and Cognitively-Based Compassion Training (CBCT; Pace et al., 2009).

Most compassion-based interventions aim to cultivate compassion both for oneself and for others, and usually begin with feeling compassion for someone for whom it is very easy to feel compassion (e.g., a mentor, friend, or pet). Once practitioners are able to experience the feeling of compassion, they are then guided to direct the same feeling of compassion to themselves. Longer-term compassion-based interventions (e.g., CBCT, CCT) build even further on one's ability to develop compassion, and eventually teach practitioners to cultivate compassion for neutral people (e.g., acquaintances, strangers), and then difficult people (e.g., those with whom one does not get along with very well), and finally, to all people and other beings. The current study examined a very brief single-session intervention, and thus, focuses only on cultivating compassion for a close other and for oneself.

Compassion-Based Contemplative Interventions and Health

A variety of compassion-based interventions have been empirically tested, including Compassion-Focused Therapy (Gilbert, 2010), Mindful Self-Compassion (Germer & Neff, 2019), CCT (Jazaieri et al., 2014), and CBCT (Pace et al., 2009). Two meta-analyses have examined the effects of these interventions on compassion for others, self-compassion, and

numerous health outcomes (Ferrari et al., 2019; Kirby et al., 2017). These meta-analyses found that compassion-based intervention groups increased both compassion for others and self-compassion relative to control groups, indicating that although compassion is often regarded as an enduring trait, it is modifiable through intervention (Ferrari et al., 2019; Kirby et al., 2017).

Regarding health outcomes, one meta-analysis found that participants in compassion-based interventions reported significantly less depression ($d = 0.64$), anxiety ($d = 0.49$), and psychological distress ($d = 0.47$) than participants in control groups (Kirby et al., 2017). The other meta-analysis examined additional health outcomes and found similar effects for depression and anxiety, along with significant improvements in self-criticism (Hedge's $g = 0.56$), rumination (Hedge's $g = 1.37$), and stress (Hedge's $g = 0.67$) in the compassion-based interventions relative to control groups (Ferrari et al., 2019). Ferrari et al. (2019) also found that depression continued to significantly improve at follow-up time points. Other outcomes (e.g., anxiety, rumination) did not have enough studies with follow-ups to evaluate the sustainability of improvements, but the follow-up results depression indicate that compassion-based interventions are effective both immediately post-intervention, and may continue to be effective even without additional training. Beyond finding positive effects for mental health outcomes, studies have also examined the effects of compassion-based contemplative interventions on stress reactivity, which I discuss in the next section.

Compassion-Based Contemplative Interventions and Stress Reactivity

In addition to demonstrating positive pre- to post-intervention outcomes, compassion-based contemplative practice seems to buffer stress when implemented prior to a psychosocial stressor, such as the TSST. For example, one study demonstrated that a brief self-compassion training buffered stress reactivity to the TSST via salivary alpha-amylase, respiratory sinus

arrythmia, and subjective anxiety ratings (but not cortisol) when compared to an attention training control intervention and a wait-list control group (Arch et al., 2014). The self-compassion intervention consisted of an initial 10-min session of a guided self-compassion meditation, three days of listening to the 10-min guided self-compassion recording at least once per day, and a final 5 min self-compassion recording during their visit to the laboratory prior to undergoing the TSST. Thus, after just 45 cumulative minutes of self-compassion training, participants demonstrated buffered stress reactivity measured via salivary alpha-amylase, cardiovascular response, and self-report (Arch et al., 2014).

To date, there have been few other intervention studies that have examined the effects of compassion-based contemplative practice on acute psychosocial stress induced via the TSST. Those that have examined these effects typically implemented long-term interventions. For example, Pace et al. (2009) implemented six weeks of CBCT for undergraduates and measured TSST-induced changes in cortisol, interleukin-6 (an inflammatory biomarker), and self-reported stress before and after the intervention. In CBCT, participants learned attention practice by paying attention to the breath (week 1); mindfulness of thoughts and bodily sensations (week 2); mindfulness to understand that all humans wish to avoid suffering and be happy, including self, friends, and "enemies" (weeks 3 and 4); generating compassion for close others (week 5); and generating compassion for friends, strangers, and those one does not like (week 6; Pace et al., 2009). After accounting for home practice time, increased engagement with the intervention material was associated with decreased interleukin-6 and self-reported stress reactivity (Pace et al., 2009).

Another recent multi-faceted study examined the ability of a variety of contemplative practices to buffer stress reactivity to the TSST (Engert et al., 2017). The main practices fell

under three distinct modules: Presence, Affect, and Perspective training. In the Presence module, participants were trained in attention and awareness. In the Affect module, participants were trained in loving-kindness and compassion, and in the Perspective module participants were trained in metacognition and perspective taking. The study compared five distinct groups: (1) a three-month Presence only training, (2) a three-month Affect only training, (3) a six-month combined Presence/Affect training, (4) a six-month combined Presence/Perspective training, and (5) a no training control group. The three-month Affect only, but not the three-month Presence only group, demonstrated decreased stress reactivity to the TSST via cortisol, indicating that compassion may have distinctive effects. However, both six-month long groups also demonstrated decreased stress reactivity via cortisol and self-report, so distinctive effects of the Affect module may not matter in this time frame (Engert et al., 2017). All studies examining the effects of compassion-based contemplative interventions on stress reactivity are summarized in Table 2.

Research examining the effects of compassion-based contemplative interventions on stress reactivity is limited in that, for the most part, interventions were relatively inaccessible. For example, only one study examined a brief intervention (Arch et al., 2014), while the others were time-intensive and required ongoing training for multiple weeks (Engert et al., 2017; Pace et al., 2009). This level of time commitment limits the accessibility of interventions. Outside of research settings, these time-intensive interventions are often also cost-prohibitive when offered to the public. For example, CBCT (i.e., the intervention from Pace et al., 2009) is offered to the public for $395 (Center for Contemplative Science and Compassion-Based Ethics, 2021). Effective single-session interventions provide advantages over longer-term interventions, including increased accessibility, cost-effectiveness, and ease of implementation (Schleider et al.,

2022). However, there is not yet an established brief, standardized, single-session compassion intervention that successfully demonstrates stress-buffering effects.

The one study that examined a brief, more accessible compassion-based intervention in this area of literature also has several limitations (Arch et al., 2014). The intervention was carried out over several days of practicing compassion using a guided recording. Further, while a strength of the study from Arch et al. (2014) was that it included an active control intervention, the control intervention consisted of participants listening to "excerpts from a psychology textbook chapter on cognition, with content plausibly relevant to TSST preparation, including discussions of problem solving, judgment, and thinking" (p. 51). Study findings may have been strengthened by using an evidence-based active control intervention, such as teaching participants skills from CBT (e.g., cognitive reappraisal training). CBT interventions are often used as evidence-based comparison groups for RCTs assessing the effectiveness of contemplative interventions (Arch et al., 2013; Butler et al., 2018; Garland et al., 2016; Shortland-Jones, 2015). Identifying whether compassion-based contemplative interventions are more effective (or at least non-inferior) at buffering against stress as a CBT intervention (i.e., a comparative efficacy trial) would extend the extant research and provide more robust rationale for incorporating compassion training into clinical practice. If research demonstrates compassion training as non-inferior to CBT training, this would also increase the number of available and effective tools for clinicians to add to their repertoire.

Beyond demonstrating comparative efficacy and increasing the number of clinical tools available, compassion training may also have benefits above and beyond CBT-based skill training such as cognitive reappraisal. Compassion training may target physiological and cognitive transdiagnostic mechanisms (e.g., stress reactivity, shame) underlying many adverse

health outcomes (Arch et al., 2014; Gilbert & Procter, 2006). In fact, some compassion training programs, like compassion-focused therapy (CFT; Gilbert, 2010), have been put forth as an alternative to CBT approaches for those who report high shame and self-criticism and for those for whom CBT approaches are ineffective (Gilbert & Procter, 2006). Compassion training includes both mind and body approaches (e.g., soothing rhythm breathing) as opposed to some CBT skills training (e.g., cognitive reappraisal), which primarily targets thoughts. Research indicates that body-based approaches (e.g., breathing practices) demonstrate positive stress-buffering effects when implemented on their own (Balban et al., 2023). Directly comparing compassion training which includes both mind and body practices with CBT skill training in a comparative efficacy trial would provide additional evidence that compassion training may be non-inferior or even have advantages over CBT skills training.

Few studies have directly compared compassion training to CBT skills training. One previous study compared brief CBT skills training in cognitive reappraisal to training in compassion and found that those in the compassion training demonstrated more altruistic behavior in a redistribution game relative to the cognitive reappraisal training (Weng et al., 2013); however, no studies have compared the effects of cognitive reappraisal and compassion training on stress reactivity. A final limitation of the Arch et al. (2014) study was that it only included women, which limits the generalizability of stress-buffering effects of brief compassion-based contemplative practice to other genders. Further investigation with mixed-gender samples is required to increase confidence in the ability of brief compassion-based contemplative practice to attenuate stress reactivity, particularly in light of research demonstrating gender differences in stress reactivity (Helminen et al., 2021; Liu et al., 2017).

Among all studies reviewed in Table 2, research on compassion-based contemplative interventions is also limited in the physiological outcomes measured. While each of the studies examining compassion-based contemplative practice and stress reactivity provide evidence that compassion-based contemplative practice has both physiological and self-report stress-buffering effects, none of them examined blood pressure reactivity. Given that blood pressure reactivity is one of the most well-understood biomarkers of the SAM system and is also a well-known predictive biomarker for cardiovascular health later in life (Carroll et al., 2001, 2011; Matthews et al., 2004, 2006; Zhao et al., 2015), it is important to understand whether compassion-based contemplative practices are able to attenuate the blood pressure reactivity to psychosocial stress.

In summary, there is evidence that compassion for others and self-compassion can be trained through intervention, along with the evidence that compassion-based contemplative interventions demonstrate improvements in health outcomes and buffer against social-evaluative stress reactivity. Given these outcomes, compassion-based contemplative interventions represent a promising approach to improving health.

Summary and Aims

Excessive stress reactivity, particularly excessive blood pressure reactivity, to psychosocial stressors is associated with poor physical and mental health outcomes (Carroll et al., 2001, 2011; Matthews et al., 2004, 2006). Individuals higher in trait compassion have demonstrated reduced physiological and self-reported stress reactivity to psychosocial stressors (Breines et al., 2015; Ceccarelli et al., 2019; Ewert et al., 2018; Luo et al., 2018). Researchers have also demonstrated that compassion can be trained through compassion-based contemplative interventions (Ferrari et al., 2019), and several studies compassion-based contemplative interventions have demonstrated the ability of these interventions to buffer stress reactivity to

induced psychosocial stress (Arch et al., 2014; Engert et al., 2017; Pace et al., 2009). While these results are promising, there are limitations in the compassion and stress reactivity literature, including (1) lack of an accessible, effective single-session standardized interventions among the few intervention studies in this area of literature and (2) limited physiological measurements – in particular, a lack of blood pressure reactivity measurement – to understand the effects of compassion interventions on stress reactivity. The current study aimed to address these limitations.

Aim 1

The first aim of this study was to develop and implement a standardized, single-session compassion-based contemplative intervention and demonstrate the ability of this intervention to increase one's level of state compassion and self-compassion and decrease SBP, DBP, HR, and state stress from pre- to post-intervention relative to a robust, evidence-based active control intervention (i.e., cognitive reappraisal training). I adapted existing materials to create (1) a 40-minute single-session compassion-based contemplative intervention, and (2) a 40-minute single-session CBT-based cognitive reappraisal training to use as an active control intervention. Self-report and physiological measurements were taken pre- and post-intervention. I hypothesized that state compassion for others and state self-compassion would increase from pre- to post-intervention in the compassion intervention relative to the active control intervention (Hypothesis 1a), and decrease SBP, DBP, HR and state stress relative to the active control intervention (Hypothesis 1b).

Aim 2

The second aim of this study was to demonstrate the stress-buffering capacity of the compassion intervention compared to the active control intervention via reduced blood pressure

reactivity, HR reactivity, and self-reported stress reactivity to the TSST-G relative to the active control intervention. Immediately after the intervention, participants underwent the TSST-G and self-report and physiological indices of stress were measured throughout the TSST-G. I hypothesized that participants in the compassion intervention would demonstrate reduced stress reactivity on both physiological and self-report measures relative to participants in the active control intervention (Hypothesis 2).

Methods

Power Analysis

I conducted a power analysis using GLIMMPSE 3.0.0 (Kreidler et al., 2013) to identify the necessary sample size to test the main effect of time on stress reactivity. For the power analysis, I used a previous study which compared a high self-compassion group to a low-self compassion group (Bluth et al., 2016). The high and low self-compassion groups were used as proxies for a compassion intervention and active control intervention groups, assuming that the compassion group would increase their compassion relative to the active control intervention in the current study and contribute to stress-buffering effects of physiological variables. Means and standard deviations for blood pressure for four time points (baseline, pre-TSST, speech preparation, and peak stress during the TSST) for each group were input into GLIMMPSE 3.0.0 to calculate the within-between interaction effect size from which to base the power analysis. GLIMMPSE 3.0.0 also allows for specifying clustering. I estimated a clustering factor of three participants per group. To achieve a power of 0.80 with a Type I error rate of 0.05, the minimum required sample size for the unit of randomization (i.e., group) was 20, requiring a sample size of approximately 60 participants with three participants per group to be sufficiently powered. This study was likely slightly underpowered with the current sample size of 50.

Participants

Inclusion criteria included university students aged 18 or older who did not have a pre-existing heart condition. Exclusion criteria included any students aged <18 years or those who had a pre-existing heart condition. Young adults (n = 59) consented to participate in this study for course credit in introductory psychology courses and completed the initial appointment for the study, which consisted of a virtual meeting with me to learn about the study and complete demographic questionnaires. Three participants missed the laboratory session of the experiment, one participant reported having a heart condition, and two participants had resting heart rates of >100 beats per minute, indicating a probable heart condition (i.e., tachycardia; Gopinathannair & Olshansky, 2015); these participants were excluded from analyses. Further, although all participants were scheduled in groups of two to five, on three separate occasions, only one participant showed up to the in-person laboratory session. Notably, the current study aimed to evaluate the effects of a group-based intervention rather than an individual intervention. Prior research indicates that the presence and performance of other participants during stress induction may influence stress reactivity (Childs et al., 2006; Vors et al., 2018). As such, I conducted analyses with and without the participants who completed the intervention and stress test individually to assess whether they influenced intervention effects. Thus, the analytic samples were 50 and 53 participants for the initial analyses and sensitivity analyses, respectively.

Self-Report Measures

Participants completed demographic measures, including gender identity, race/ethnicity, sexual identity, and income. State compassion and state self-compassion were measured with the Compassion Scale (Pommier et al., 2020) and the State Self-Compassion Scale, Short Form

(Neff et al., 2021), respectively. The six-item State-Trait Anxiety Inventory (Marteau & Bekker, 1992) was used to measure self-reported stress reactivity.

Demographic Questions

Gender identity was assessed with a two-part question (Kronk et al., 2022). First, participants were asked to select their gender identity from a list of options (i.e., woman, man, non-binary, genderqueer, gender-fluid, agender, Two-spirit, or an option to self-identify with a write-in text box). Next, participants were asked if they considered themselves to be transgender, with a list of options, including "Yes, transgender woman," "Yes, transgender man," "Yes, transgender non-binary," "Yes, I wish to self-identify" with a write-in text box, or "No." Gender was coded as cisgender women (0) and cisgender men (1). No participants with other gender identities screened into the study.

Race/ethnicity was assessed with one question that asked participants to select their racial/ethnic identity/identities from a list of 10 options (i.e., American Indian or Alaska Native, Asian, Black or African American, Native Hawaiian or Other Pacific Islander, Latina/Latino/Latinx or Hispanic, Middle Eastern, Biracial, Multiracial, White, or an option to self-identify with a write-in text box). Participants' race/ethnicity was coded as white (0) or person of color (1).

Sexual identity was assessed with one question that asked participants to select their sexual identity/identities from a list of 11 options (i.e., bisexual, pansexual, queer, demisexual, fluid, gay, lesbian, asexual, unsure/questioning, straight or heterosexual, or an option to self-identify with a write-in text box). Participants' sexual identity was coded as heterosexual (0) or sexual minority (1).

Household income was assessed by asking participants to report their estimated household income in the past year from six response options (i.e., under $10,000; $10,000-$24,999; $25,000-$49,999; $50,000-$74,999; $75,000-$99,999; or over $100,000). Household income was defined as (1) income from the participant and their parent(s)/guardian(s) if they were a dependent; (2) income from themselves and their dependents if they lived on their own with dependents; and/or (3) income from themselves and a partner if they lived with a partner. A dependent was defined as someone who receives over 50% of their financial support from another person (IRS, 2022). Response options were coded from 1 (under $10,000) to 6 (over $100,000).

Trait Self-Compassion

The Self-Compassion Scale (SCS) is a 26-item measure constructed to assess trait self-compassion (Neff, 2003). The scale includes items for six subscales posited to tap into opposing elements of self-compassion, including self-kindness vs. self-judgment, common humanity vs. isolation, and mindfulness vs. overidentification. Research has indicated that the negative subscales (i.e., self-judgment, isolation, and overidentification) may be redundant with certain personality traits (e.g., neuroticism) rather than measuring elements of self compassion (Pfattheicher et al., 2017). Thus, only the positive subscales (i.e., self-kindness, common humanity, and mindfulness) were administered to participants (Muris & Petrocchi, 2017). Participants are asked how often they typically act toward themselves (e.g., “I’m kind to myself when I am suffering”) and responses include options from 1 (*almost never*) to 5 (*almost always*). A mean trait self-compassion score is calculated from all items (range = 1 to 5), with higher scores indicating higher trait self-compassion. The SCS demonstrated adequate internal

consistency (α = 0.92) in the original study (Neff, 2003). Similarly, in the present study, the SCS demonstrated adequate internal consistency (α = 0.92).

Compassion Scale Adapted to be a State Measure

Given that no measures of compassion for others have explicitly been developed to measure state psychological functioning, I used the 16-item Compassion Scale (CS; Pommier et al., 2020) and changed the prompt in the beginning to examine state compassion for others. The original prompt states, "Indicate how you feel or behave in the stated manner on a scale from 1 (*almost never*) to 5 (*almost always*)." The prompt was changed to "Indicate how you are feeling or how you would behave in the stated manner right now on a scale from 1 (*almost never*) to 5 (*almost always*)." Scale items are presented in present tense (e.g., "My heart goes out to people who are unhappy") and thus, amenable to measuring state compassion for others with the additional prompt. Total scores on the CS range from 16 to 80, with higher scores indicating higher compassion for others. The CS has demonstrated adequate internal consistency (α range = 0.77 – 0.90) across samples of college students, community members, and experienced meditators (Pommier et al., 2020). In the present study, the state CS demonstrated adequate internal consistence at baseline (α = 0.82) and post-intervention (α = 0.84).

State Self-Compassion Scale-Short Form

The State Self-Compassion Scale, Short Form (SSCS-S) is a six-item measure constructed and validated to detect changes in self-compassion (Neff et al., 2021). Items are written in the present tense (e.g., "I'm giving myself the caring and tenderness I need") and are scored on a scale from 1 (*almost never*) to 5 (*almost always*). The possible range of scores is from 6 to 30, with higher scores indicating higher state self-compassion. In the development and validation study, the SSCS-S was evaluated before and after a self-compassionate mind state

induction, and it demonstrated adequate fit for a one factor solution at both time points. State self-compassion significantly increased from pre- to post-self-compassionate mind state induction relative to a control group, indicating that the measure is sensitive to self-compassion training. The SSCS-S demonstrated adequate internal consistency at both pre-induction (α = 0.72) and post-induction (α = 0.81) in the original study (Neff et al., 2021). Similarly, in the present study, the SCSS-S demonstrated adequate internal consistency at baseline (α = 0.76) and post-intervention (α = 0.80)

Shortened State Trait Anxiety Inventory

The six-item State-Trait Anxiety Inventory (STAI-6) is a widely used and validated measure that is sensitive to social-evaluative stress induction (Morton et al., 2020). The original STAI consists of a state anxiety questionnaire and a trait anxiety questionnaire. Marteau and Bekker (1992) created a shortened version of the state scale that includes six questions. Items are written in present tense (e.g., "I feel upset") and is scored on a scale from 1 (*not at all*) to 4 (*very much so*). The possible range of scores on this measure is from 6 to 24, with higher scores indicating higher state stress. The shortened STAI-6 has demonstrated adequate internal consistency in the original study (α = 0.82; Marteau & Bekker, 1992). The STAI-6 also demonstrated adequate internal consistency in the present study at baseline (α = 0.84), post-intervention (α = 0.85), and post-TSST-G (α = 0.87).

Perceptions of TSST-G Stressfulness

Prior to debriefing participants at the end of the study, participants were asked to report their perceptions of stressfulness of the TSST-G using the question, "Did you find the interview/math portion of the experiment to be stressful?" with response options of 1 (*Not at all*), 2 (*Somewhat*), 3 (*Moderately so*), and 4 (*Very much so*).

Physiological Measures

Physiological variables used to measure activation of the SAM system include blood pressure (both SBP and DBP) and HR. SBP is the arterial pressure measured when the heart pumps blood through the body, DBP is the resting arterial pressure measured between heart beats, and HR is the number of times the heart beats in one minute (Whelton et al., 2018).

Blood Pressure

Both SBP and DBP were collected via SunTech Medical Oscar 2 Ambulatory Blood Pressure Monitor and Orbit Ambulatory Blood Pressure Monitor Cuff. This blood pressure measuring system has been clinically validated (Goodwin et al., 2007; Jones et al., 2004), and has been independently tested to meet requirements set by the British Hypertension Society, the European Society of Hypertension International and the Association for the Advancement of Medical Instrumentation (Whelton et al., 2018). This device records blood pressure via a non-invasive, automated, ocillometric stepwise sphygmomanometer (i.e., blood pressure cuff) that goes around the upper arm. Ocillometric BP machines are able to detect vibrations caused by the flow of blood through the brachial artery in the upper arm. The cuff inflates to a pressure above that of the arterial pressure, causing the vessel to close, and then it slowly deflates. During deflation, the cuff passes the SBP, which is the pressure in the artery immediately after the heart pumps. When the cuff pressure falls below the SBP, the pressure in the brachial artery is enough to open the vessel after a heart pump, causing a vibration in the cuff (A. Berger, 2001). The device records the pressure at which this happens, which is termed the SBP.

Between heart pumps, the pressure in the brachial artery is not enough to overcome the pressure of the cuff when the cuff is still near the SBP level. As the cuff continues to deflate, it will reach a pressure at which it will no longer be able to compress the brachial artery between

heart pumps. The resting pressure of the artery between heart pumps is known as the DBP. When the cuff pressure falls below this point, it is no longer be able to feel the vibrations of the artery opening and closing, and the machine records the pressure at which this shift occurs (i.e., the DBP; A. Berger, 2001).

Heart Rate

Heart rate was also measured using the SunTech Medical Oscar 2 BP monitor. This machine records heart rate in a similar manner to blood pressure described above. When the blood pressure cuff falls below the SBP level, but has not yet reached the DBP level, it is recording the vibrations of the brachial artery opening and closing with each heart pump. Measuring the number of heart pumps during this time allows the machine to calculate heart rate in beats per minute (bpm).

Fidelity of Implementation

One or two undergraduate research assistants (RAs) coded for fidelity during each intervention session. Prior to the data collection, RAs were trained on fidelity coding during two mock sessions of intervention delivery and were considered ready to implement the study when they achieved 100% accuracy (i.e., correctly indicated for each item whether the interventionist implemented the item or not) in monitoring fidelity. Core aspects of each intervention were listed in an online survey with the response options of "Yes" or "No," which indicated whether the interventionist completed each aspect of each intervention. Intervention fidelity forms for the compassion intervention and the active control intervention are included in Appendix A and Appendix B, respectively.

Participant Engagement

RAs also coded for overall participant engagement for each group of participants. Based on previous research on behavioral indices of engagement in college students (Alicea et al., 2016), RAs were provided with examples of engagement (e.g., facing the interventionist, following interventionist instructions, responding to interventionist questions) and examples of non-engagement (e.g., looking around the room, not responding to questions). At the end of each intervention session, RAs responded to the question, "As a group, how engaged did the participants appear to be during the intervention?" using a scale from 1 to 7, with anchors at 1 (*Not at all engaged*), 4 (*Sometimes engaged, sometimes not engaged*), and 7 (*Very engaged*).

Participants were also asked a question to assess their perception of engagement prior to debriefing at the end of the study. The question asked, "How well do you think you were able to follow the directions during the intervention portion of the experiment?" with options including 1 (*Not at all*), 2 (*Somewhat*), 3 (*Moderately so*), and 4 (*Very much so*). At the beginning of each intervention session, participants were told that the "intervention" that they volunteered for consisted of an interventionist teaching them a potentially helpful skill.

A final set of engagement questions were related to whether participants were able to use a stress management skill during the TSST-G. These questions were also presented at the end of the experiment, prior to debriefing. First, participants were asked, "Did you use any strategies or practices to reduce feelings of stress during the combined interview/math part of the experiment?" with response options of "No," "Somewhat," "Yes," or "I don't remember." Those who answered with "Somewhat" or "Yes" were asked two additional questions, including (1) "Did you use a strategy that you learned today?" with response options of "No," "Yes," and "I don't remember;" and (2) "Did you find the strategy you used to be helpful/effective for

reducing feelings of stress?" with response options of 1 (*Not at all*), 2 (*Somewhat*), 3 (*Moderately so*), and 4 (*Very much so*).

Procedure

All study procedures were approved by Syracuse University's Institutional Review Board (protocol # 21-361). Procedures consisted of (1) a virtual meeting via Zoom where participants met with me, learned about the study, and completed self-report questionnaires, and (2) a single in-person session at the lab within two weeks of the Zoom meeting, where participants either completed the compassion intervention or active control intervention and underwent the Trier Social Stress Test for Groups (TSST-G; von Dawans et al., 2011). A schematic of the single in-person session is detailed in Figure 1. To participate in the study, participants were required to sign up for both parts simultaneously using Sona Systems (https://www.sona-systems.com).

The virtual meeting was implemented to reduce the overall length needed for the in-person portion of the experiment. Participants met with me over Zoom. In this meeting, participants consented to the study and completed a set of online questionnaires (e.g., demographic questions, inclusion criteria). I then confirmed participants' in-person appointment and reminded them to avoid wearing bulky clothing (e.g., sweatshirts) to the in-person session as they would need to wear a blood pressure cuff around their upper arm for the duration of this session.

The in-person session took place in one large conference room that allowed for social distancing and was outfitted with an air purifier. Participants were scheduled in groups of 2 to 5 at a time based on the availability they provided when signing up for the study on the Sona Systems website. When participants arrived at the laboratory, they were welcomed into a large conference room and asked to select a chair on one side of the room to place their belongings for

the duration of the experiment. Participants were asked to silent their phones and leave their phones with the rest of their belongings. Participants were then asked to sit in chairs on the opposite side of the room, where they remained for the duration of the experiment. Once seated in the designated chairs, participants were outfitted with an ambulatory blood pressure monitor device and accompanying carrier pouch. Cuffs were secured on the participant's upper non-dominant arm. Participants were provided with FDA-approved masks with a clear insert that made it possible for the interventionist and TSST panel to see participants' mouths (Safe'N'Clear, Inc., 2021). Previous research has indicated that participants more accurately recognize neutral facial expressions when experimenters' mouths are visible (Guarnera et al., 2015). Masks which allowed the panelists' mouths to be visible were selected given the importance of neutral affect to the stressfulness of the TSST (Goodman et al., 2017).

After blood pressure devices were in place, participants completed time-sensitive baseline self-report data that was unable to be collected at the Zoom meeting ahead of time (e.g., baseline state stress) on iPads provided by RAs. Participants then read neutral content magazines (e.g., home decorating) until 25 minutes elapsed from the time they arrived and sat down in their assigned chair to ensure that their blood pressure and heart rate was stabile (Mahe et al., 2017). Three baseline blood pressure and heart rate measurements were then taken, spaced apart by one minute (Whelton et al., 2018). Upon completing the baseline measurements, the monitor face of the blood pressure machine was covered with a piece of tape for the rest of the experiment to prevent potential biofeedback effects (Tsai et al., 2007).

After the baseline readings, participants completed the group intervention to which they were randomly assigned (i.e., the compassion intervention or the active control intervention). I was the interventionist for all sessions, and I implemented the interventions according to

standardized procedures (see Appendices A and B). I also wore a mask with a clear insert (Safe'N'Clear, Inc., 2021) to better facilitate interaction. Each intervention session lasted 40 minutes. One to two RAs were in the large conference room during each intervention session to code for implementation fidelity and participant engagement.

After the intervention, a post-intervention measurement of SBP, DBP and HR were completed. Immediately after this measurement period, participants underwent the TSST-G. RAs brought in the accessory material necessary for the TSST-G (see Experimental Manipulation section for more details). Members of the TSST-G panel also wore masks with clear inserts (Safe'N'Clear, Inc., 2021) to ensure participants were aware of their neutral facial expressions. SBP, DBP, and HR readings were completed after the speech preparation, in the middle of the speech task, at the end of the speech task, in the middle of the math task, and at the end of the math task. All measurements were completed while the participant was seated to mitigate against confounds due to orthostatic changes in BP (Eşer et al., 2007).

Experimental Manipulation

Participants who signed up for the same day and time of the experiment were cluster randomized in groups of two to five to the compassion intervention or the active control intervention. Procedures for the compassion intervention and the active control intervention are described briefly below and in detail in Appendix A and Appendix B, respectively.

Compassion Intervention

The compassion intervention consisted of three distinct phases drawn from the basic principles of compassion-focused therapy (CFT; Gilbert, 2009; Gilbert & Procter, 2006). CFT posits that one's suffering may stem from an overactive threat system and an underactive self-soothing system. Through CFT, one is able to (1) learn how to tap into the physiological

soothing system, (2) understand how one has learned patterns in an environment that may have made it difficult to be compassionate to oneself and others, and (3) understand how one can use experiential practices to build the skill of compassion (Gilbert, 2010). The compassion intervention phases addressed these aspects of CFT to help participants develop compassion. I was the interventionist for all sessions. I am a trained school psychology doctoral student, was formally trained in CFT, and I have several years of experience in providing individual and group-based instruction in contemplative practice in both clinical and research settings.

The first phase consisted of a five-minute experiential practice in which the participants practiced soothing rhythm breathing (Cattani et al., 2021). I directed participants to slow their breathing using a five-count inhale and five-count exhale (see Appendix A). The second phase of the intervention consisted of didactic instruction on compassion, why it can be difficult to be self-compassionate, and how compassion is a skill that can be cultivated. The first and second phases were adapted from the beginning sessions of a manualized treatment protocol for CFT (Cattani et al., 2021). The third phase of the intervention consisted of an experiential compassion practice adapted from previous research (Weng et al., 2013) that encompassed cultivating feelings of compassion for a loved one and then for oneself. I guided participants through imagining their loved one and then remembering or picturing a time when their loved one was suffering. Upon imagining this suffering, participants were instructed to pay attention to feeling of compassion towards their loved one. I then guided participants to apply these feelings they generated for their loved one to oneself. The interventionists scripts for each phase are included in Appendix A.

Active Control Intervention

The active control intervention was matched to the compassion intervention in total time (40 minutes) and included didactics and experiential exercises. The active control intervention consisted of three distinct phases built upon the principles of cognitive-behavioral therapy (CBT). CBT can be used to (1) teach participants that thoughts, feelings, and behaviors are connected; (2) understand how one's thoughts can influence how one feels and either soothe or exacerbate stressful situations; and (3) teach strategies (e.g., cognitive reappraisal) to change the way one might think about stressful situations (Hofmann et al., 2012; Kazantzis et al., 2018). The phases of the brief cognitive reappraisal training control intervention addressed these aspects of CBT to help participants develop cognitive reappraisal skills. I was the interventionist for all sessions. I have been formally trained in CBT, and I have several years of experience in providing individual and group-based instruction in CBT in clinical and research contexts.

The first phase of the active control intervention consisted of five minutes of reading an article that describes how thoughts, feelings, and actions are considered in psychology, and how they are connected to each other. Participants were given a set of questions to consider as they read through the article (see Appendix B). This activity was chosen to provide an introduction to thoughts, feelings, and behaviors, which is how CBT interventions often begin to establish a shared working knowledge of the material (Cully et al., 2020). The second phase of the active control intervention consisted of didactic instruction regarding the connection between thoughts and feelings, particularly when thinking about something stressful. The third phase of the intervention consisted of completing a cognitive reappraisal worksheet adapted from previous research (Weng et al., 2013) and guided by the interventionist. Participants were asked to consider different perspectives and write about how those perspectives might make them feel

less stressed during a stressful situation. Participants were told that they could keep these worksheets following the intervention to encourage full participation in case of privacy concerns.

TSST-G Implementation

This study implemented the TSST-G (von Dawans et al., 2011), with a slight modification to the speech task. To begin, RAs brought accessories needed for the TSST-G into the large conference room after the completed intervention portion of the experiment. Accessories included a table and two chairs for the TSST-G panelists. Dividers were also brought into the room and placed between each participant to limit interaction and possible social support effects during the TSST-G (von Dawans et al., 2011). A video camera was placed on the table facing the participants. Participants were led to believe that the video camera was recording throughout the TSST-G. The TSST-G panel consisted of two RAs who were masked to condition assignment. Panelists entered the room wearing white lab coats. Participants were told that the panelists were experts in speech and nonverbal behavior and that their videorecording would also be reviewed by experts to assess their performance.

The TSST-G consisted of three phases. In the original TSST-G protocol, panelists instruct participants to think about why they would be the perfect candidate for their ideal job. For the present study, the speech prompt was modified to instruct participants to think about how they would introduce themselves to a new class and to consider both their strengths and weaknesses. This speech topic was chosen as it may have greater validity in younger populations who may not have had many job interviews, and it has been used to successfully induce stress in previous studies (Hostinar et al., 2014; Yim et al., 2015). Participants were provided three minutes to consider their answer to this question (von Dawans et al., 2011). One of the panelists

placed a kitchen timer set to three minutes on the table facing participants so they would know how much time they had left to prepare.

Once the period was over, the speech task began. Participants were selected in seemingly random order by TSST-G panelists; however, the order was standardized across administrations. Once a participant's number was called, they were given two minutes to give a speech about how they would introduce themselves to a new class. If a participant stopped talking before the two minutes are up, panelists prompted them by saying "Please continue, you still have some time left."

Once all participants completed the speech task, the mathematic task phase began. Again, participants were called on in seemingly random order, but order was standardized across sessions. Each participant received a different starting number to mitigate against practice effects. They were then told to serially subtract either 13 or 17 from that number. For example, the first participant may be given the starting number of 1023 and told to sequentially subtract 17 from that number. When participants were selected, they performed the serial subtraction task for 1 minute and 20 seconds each. When participants made a mistake, a panelist asked them to stop and restart from the beginning number.

After the experiment was over, participants were debriefed to the true nature of the experiment. They were informed that they were not actually being videotaped or evaluated by experts. They were also given the opportunity to ask questions about the experiment.

Data Analyses

Diagnostics and Data Cleaning

SBP, DBP, and HR data were downloaded from the SunTech Medical Oscar 2 Device after each experimental session. Data were imported onto a computer and viewed with the

proprietary software from SunTech Medical, AccuWin Pro v4 (SunTech Medical, 2018). Values for SBP, DBP, and HR were downloaded from the software into a spreadsheet for analyses.

SBP, DBP, HR, state stress, state compassion for others, and state self-compassion data were evaluated for normality visual inspection and Shapiro-Wilk tests. In cases where variables were not normally distributed based on a significant Shapiro-Wilk test, skewness and kurtosis values were examined. If variables demonstrated skewness and kurtosis values outside of ±2 (D. George & Mallery, 2010), I planned to transform (e.g., $\log_{10}$ transformation) the data and reassessed for normality. If they still demonstrated non-normal distributions, I planned to winsorize outliers to three standard deviations above or below the mean (Weston & Gore, 2006).

SBP, DBP, and HR were collected at seven time points (i.e., baseline, pre-TSST-G, speech preparation, mid speech task, end of speech task, mid math task, end of math task; see Figure 1). The maximum SBP, DBP, and HR measurement across four time points during the speech and math tasks for each participant was coded as the peak stress measurement. This reduced the number of time points for analysis to four time points (i.e., baseline, pre-TSST-G, speech preparation, peak stress). This decision was made because the order of participant performance during the speech and math tasks determined when their measurements were taken relative to their performance. For example, the participant who performed the speech task first would have their mid speech task measurement taken *after* they already performed, whereas the participant who performed the speech task last would have their mid speech task measurement taken *before* performing their speech. Since the speech performance is one of the main stressful aspects of the TSST-G, a participant who is anticipating performing the speech may be experiencing different physiological reactions compared to a participant who completed that

portion of the task. Indeed, some research with the TSST-G has demonstrated that speech order influences stress reactivity (Hostinar et al., 2014).

Another reason for combining these time points into a peak stress measurement is because the primary aim of this study is to assess the effects of an intervention on stress reactivity, which is typically operationalized from baseline to peak stress measurement (Goodman et al., 2017; Helminen et al., 2019, 2021; Liu et al., 2017; Seddon et al., 2020). Further, the magnitude of stress reactivity (i.e., change from baseline to peak stress) is the index by which many studies use stress reactivity to predict adverse health outcomes (Matthews et al., 2004, 2006; Zhao et al., 2015). Further, I assessed whether participants in this study experienced variation in their peak SBP, DBP, and HR measurements, and I found that the peak stress time point varied considerably. For SBP, 23 participants (46%) experienced their highest SBP during the mid-speech task measurement, 13 (26%) at the end of speech measurement, 10 (20%) at the mid math task measurement, and 4 (8%) at the end of math measurement. For DBP, 25 participants (50%) experienced their highest DBP during the mid-speech task measurement, 9 (18%) at the end of speech measurement, 15 (30%) at the mid math task measurement, and 1 (2%) at the end of math measurement. For HR, 23 participants (46%) experienced their highest HR during the mid-speech task measurement, 6 (12%) at the end of speech measurement, 16 (32%) at the mid math task measurement, and 5 (10%) at the end of math measurement. These data indicate wide variability in when participants experienced peak stress. Recoding these time points to reflect a single peak stress measurement allowed me to establish comparability between participants, and more accurately assess the effects of the compassion intervention on stress reactivity. While the reduction in number of repeated measurement points reduces power, my

power analysis was based on four time points, and thus, is applicable to the reduced number of measurements I used in analyses (i.e., four measurement points).

Descriptive Statistics

Descriptive statistics were conducted using SPSS, version 27. Counts and percentages were calculated to describe the sample's gender, race/ethnicity, sexual identity, and income. Means and standard deviations were calculated to describe the sample's age, state compassion for others, state self-compassion, SBP, DBP, HR, and state stress across time points. Pearson's *r* correlations were calculated for continuous study variables.

Random Assignment Evaluation

Baseline measures of all variables were compared between the compassion intervention and active control intervention groups to ensure the cluster randomization process was effective. Categorical variables (i.e., gender, race/ethnicity, sexual identity, income) across groups were analyzed using Chi-square tests. Potential differences in age and group size between groups were assessed with independent samples *t*-tests. Baseline outcome variables (i.e., SBP, DBP, HR, state stress, state compassion, state self-compassion) were analyzed using a multivariate analysis of variance (MANOVA) to identify whether there were significant differences between groups at baseline.

Fidelity of Implementation

Fidelity of implementation for each session was computed as the percentage of intervention components successfully implemented. Fidelity coders used standardized fidelity forms (see Appendices A and B) to indicate whether the interventionist successfully completed each intervention component. Fifteen out of 19 sessions (79%) were dual coded by two research assistants to establish inter-rater reliability (IRR) for implementation fidelity. IRR was calculated

as percent agreement (i.e., number of agreements / total number of data points * 100; McHugh, 2012). IRR was calculated based on agreement for each individual component of each intervention.

Participant Engagement

Mean engagement ratings of observable participant behavior were computed. For sessions that were dual-coded, participant engagement ratings from coders were averaged. An independent samples *t*-test was conducted to determine whether there were significant differences in engagement ratings between groups. An independent samples *t*-test was also conducted to examine whether participants' self-reports of engagement differed by condition. A Chi-square test was conducted to evaluate whether the use of a stress-reduction strategy during the TSST-G differed by condition.

Covariate Selection

All demographic data (i.e., age, gender, race/ethnicity, sexual identity, and household income) and trait self-compassion were considered as potential covariates, as each of these factors can influence stress reactivity to the TSST (Allen et al., 2014, 2016; Breines et al., 2015; Ewert et al., 2018; Juster et al., 2015; Liu et al., 2017; Luo et al., 2018; Raffington et al., 2018). Demographic variables which significantly differed between the compassion and active control intervention groups were included as covariates to control for chance imbalance between groups in the randomization process (Kahan et al., 2014). Gender was significantly different across groups, and thus, gender was included as a covariate in all analyses.

Model Selection

Intervention effects were analyzed using linear mixed models (LMMs) in R (R Core Team, 2021) with the *nlme* package (Pinheiro et al., 2022). LMMs were selected to test

intervention effects, as they have several advantages over repeated-measures ANOVAs (RM-ANOVAs) when analyzing repeated-measures data. First, LMMs are able to use all available data from each participant despite missing data, whereas RM-ANOVAs use listwise deletion when handling missing data. Second, LMMs can account for clustering of measurements within individuals by including participant as a random effect in the model and allowing the intercept, slope, or both intercept and slope to vary for each participant. Finally, LMMs account for the nonindependence of the repeated measures within participants, whereas RM-ANOVAs assume independence of measurements (Schober & Vetter, 2018).

For each LMM described below, several steps were taken to select the best fitting model. First, I plotted each dependent variable over time separately for each participant with their own regression line and displayed these in a Trellis plot. Next, I constructed box plots to display the distribution of individual intercepts and slopes to depict the extent to which intercepts and slopes varied across participants. I used these Trellis and box plots to visualize which random effects may be appropriate (i.e., random intercepts, random slopes, or random intercepts and random slopes). Both axes were set at the same scale for each participant for visual inspection of differences in slopes and intercepts. Each set of Trellis plots and boxplots appeared to visually demonstrate enough variability in slope and intercept to warrant testing and comparing LMMs with random effects for intercepts and slopes. Figures 2 and 3 demonstrate the variability in intercepts and slopes in Trellis plots and boxplots, respectively, using the DBP reactivity data as an example.

To begin the model testing and selection process, I first fit each model as a general linear model with fixed effects only to obtain a model from which to test the goodness-of-fit for subsequent models. I then conducted LMMs by first adding random effects for the intercept, and

then for both intercept and slope. I compared model fit indices (i.e., Akaike information criterion [AIC], Bayesian information criterion [BIC]) across models and conducted likelihood ratio tests (LRT) between nested models to compare goodness-of-fit. Models with significant LRTs which minimized AIC and BIC were selected as the final models.

For all final models, I tested the assumptions for linear mixed models regarding residuals, including assumptions of zero mean, normal distribution, linearity, and constant variance. First, I calculated the mean of residuals to ensure they were at or near zero. Next, I plotted a histogram of the residuals for each model to ensure they followed a normal distribution. I then plotted residuals against values of the dependent variable. Finally, I plotted residuals against fitted values to assess constant variance. All models' mean residuals were at or near zero, distribution of residuals appeared normally distributed, residuals appeared linearly related to dependent variables, and residuals appeared to demonstrate constant variance. Figure 4 displays the plots assessing these assumptions using DBP reactivity data as an example.

Pre- to Post-Intervention Effects

Two LMMs were implemented to assess changes in state compassion for others and state self-compassion from pre- to post-intervention. State compassion for others and state self-compassion were specified as the dependent variables in each model. Gender, condition, and time were entered as fixed-effect predictors, as well as the interaction between condition and time to assess intervention effects. For both state compassion for others and state self-compassion, model comparisons indicated that the best fitting model was when the intercept was included as a random effect (Table 3), allowing the intercept to vary across participants. The interaction term was assessed for significance to determine whether changes in compassion varied by condition assignment.

Four LMMs were implemented to assess changes in stress variables (i.e., SBP, DBP, HR and state stress) from pre- to post-intervention. Stress variables were specified as the dependent variable in each model. Gender, condition, time, and the interaction between condition and time were entered as fixed-effect predictors. For all physiological variables, model comparisons indicated that the best fitting model was when the intercept was included as a random effect. For state stress, model comparisons indicated the best fitting model was when both intercept and slope were included as random effects (Table 3). The interaction term was assessed for significance to determine whether changes in stress variables varied by condition assignment.

Intervention Effects on Stress Reactivity

Four LMMs were implemented to assess stress reactivity for physiological (i.e., SBP, DBP, HR) and state stress across time points from baseline to peak stress. Stress variables were specified as the dependent variable in each model. Gender, condition, time, and the interaction between condition and time were entered as fixed-effect predictors. For all stress variables, model comparisons indicated that the best fitting model was when the intercept was included as a random effect (Table 4). The interaction term for each model was assessed for significance to determine whether stress reactivity varied by condition assignment.

An independent samples *t*-test was conducted to assess intervention effects on participants' perceptions of TSST-G stressfulness. Condition assignment was specified as the between-subjects factor, and each rating was specified as the dependent variable.

Post-Hoc Analyses

For the LMMs with repeated measures, post-hoc *t*-tests were conducted to further clarify results. If significant effects were found for the interaction between time and condition, independent samples *t*-tests were used to compare change scores (i.e., change in dependent

variable from baseline to post-intervention or from baseline to peak stress) between groups. Between-groups Cohen's *d* effect sizes (*d*) were calculated to describe the magnitude of difference between change scores for each group. If significant effects were found for time, but *not* for the interaction between time and condition, paired-samples *t*-tests were used to understand how the variable changed from pre- to post-intervention or from baseline to peak stress across the full sample. Repeated-measures Cohen's *d* effect sizes (d_{rm}) were calculated to describe the magnitude of the change. Cohen's d_{rm} accounts for the correlation between the repeated measures (Lakens, 2013). Effect sizes were interpreted according to Cohen's (1988) recommendations of small (0.2), medium (0.5), and large (0.8) effects. Significance values for post-hoc analyses were adjusted according to Benjamini-Hochberg procedures (Benjamini & Hochberg, 1995) to control the false discovery rate.

Sensitivity Analyses

I performed sensitivity analyses by redoing analyses with the three participants originally excluded based on completing the in-person session individually. All analyses were repeated with these participants included, and results were compared to original analyses to determine whether inclusion of these participants influenced effects.

Results

Missing Data

There were no missing data across demographic variables, trait self-compassion, state compassion for others, state self-compassion, or state stress. There were missing data for SBP, DBP, and HR at the pre-TSST-G time point (n = 1; 2%) and at the speech preparation time point (n = 6; 12%). There were also missing data across the four time points during the speech and math tasks of the TSST-G (range n = 1 – 3; 2% – 6%). However, since the maximum

measurement was recoded to be the peak stress time point, all participants had data for the peak stress time point. Missing data at the pre-TSST-G time point for one person was due to the blood pressure machine malfunctioning. The relatively larger amount of missing data at the speech preparation time point was due to experimenter error. Data were mistakenly not collected at this time point during the first several experimental sessions; however, this was remedied as soon as it was noticed. Nevertheless, all participants were retained for analysis regardless of missing data at the pre-TSST-G or speech preparation time points given that LMMs were used, which are able to use all available data even when one or more data points are missing.

Diagnostics and Data Cleaning

All physiological data at each time point demonstrated normality with non-significant Shapiro-Wilk tests, except for the pre-TSST-G DBP measurement, which demonstrated a significant Shapiro-Wilk test ($W = 0.95$, $p = .03$). However, upon further inspection of the pre-TSST-G DBP distribution, there were no outliers at this time point, and the skewness and kurtosis values were well within the range of ±2, which are considered acceptable to assume a normal distribution (D. George & Mallery, 2010). Thus, no physiological data were transformed. State compassion for others and state self-compassion demonstrated normality at both baseline and post-intervention time points with non-significant Shapiro-Wilk tests. State stress data produced significant Shapiro-Wilk tests at baseline ($W = 0.93$, $p = .005$) and post-intervention ($W = 0.88$, $p < .001$) time points. Similar to previous variables that produced a significant Shapiro-Wilk test, inspection of the skewness (range = 0.43 – 1.0) and kurtosis (range = -0.85 – 0.66) for the state stress data indicated they were within the acceptable range.

Sample Characteristics

The overall sample included 24 (48%) cisgender women and 26 (52%) cisgender men who were on average 19.1 years old (*SD* = 1.0). Participants reported their race/ethnicity as white (*n* = 19; 38%), Asian (*n* = 12; 24%), Black/African American (*n* = 8; 16%); multiracial (*n* = 6; 12%); Latino/Latina/Latinx (*n* = 4; 8%), and Middle Eastern (*n* = 1; 2%). Most participants were straight/heterosexual (*n* = 41; 82%), followed by gay (*n* = 2; 4%), bisexual or pansexual (*n* = 3; 6%), questioning/unsure (*n* = 2; 4%), lesbian (*n* = 1; 2%), or endorsed multiple sexual identity labels (*n* = 1; 2%). Most participants reported their household income as >$100,000 annually (*n* = 28; 56%), followed by $50,000-$74,999 (*n* = 6; 12%), $10,000-$24,999 (*n* = 6; 12%), $75,000-$99,999 (*n* = 5; 10%), $25,000-$49,999 (*n* = 3; 6%), and <$10,000 (*n* = 2; 4%).

At baseline, participants reported an average SBP of 115.1 mmHg (*SD* = 11.1), DBP of 67.7 mmHg (*SD* = 7.0), HR of 77.6 bpm (*SD* = 9.6), state stress of 36.4 (*SD* = 12.7; range = 20 – 63.3), state compassion for others of 4.1 (*SD* = 0.45; range = 3.06 – 4.94), and state self-compassion of 3.3 (*SD* = 0.75; range = 1.67 – 4.67). Descriptive statistics for each group are detailed in Table 5. Pearson's *r* correlations for continuous variables are detailed in Table 6.

Assessment of Random Assignment

Chi-square analyses revealed a significant difference between groups for gender, $X^2(1, N = 50) = 3.89$, $p = .049$. As such, gender was included as a covariate in all subsequent analyses. Due to small cell sizes, race/ethnicity, sexual identity, and household income were collapsed into white participants and participants of Color, heterosexual participants and sexual minority participants, and household income of <$50,000 or ≥$50,000, respectively. Chi-square analysis revealed no significant differences between groups for race/ethnicity, $X^2(1, N = 50) = 1.53$, $p = .22$, sexual identity, $X^2(1, N = 50) = 0.06$, $p = .81$, or income $X^2(1, N = 50) = 0.04$, $p = .85$.

Results of the *t*-tests demonstrated no significant differences between groups for age, $t(48) = 0.53$, $p = .60$, $d = 0.15$, intervention group size, $t(27) = 0.66$; $p = .52$, $d = 0.31$, or trait self-compassion, $t(48) = -0.37$, $p = .71$, $d = -0.10$. Results of the MANOVA demonstrated no significant differences in dependent outcomes (i.e., SBP, DBP, HR, state stress, state compassion for others, or state self-compassion) between groups at baseline, $F(6, 43) = 1.45$, $p = .22$; Wilk's $\Lambda = 0.82$, partial $\eta 2 = .17$.

Fidelity of Implementation

Overall, 15 out of 19 (79%) of intervention sessions were dual coded for fidelity. Eight out of 10 (80%) compassion intervention sessions and 7 out of 9 (78%) of active control intervention sessions were dual coded. The compassion intervention was implemented with 100% fidelity in all but one session. Using the coder who reported that the intervention component was not implemented accurately, one compassion intervention session was implemented with 94% fidelity, and the other nine sessions were implemented with 100% fidelity. IRR was 100% for seven compassion intervention sessions that were dual coded, and 94% for one compassion intervention session. The active control intervention was implemented with 100% fidelity for all sessions. IRR was 100% for all seven active control intervention sessions that were dual coded.

Participant Engagement

On average, coders reported mean ratings of observed engagement at 5.9 ($SD = 0.78$, range = 4.5 – 7), corresponding to an engagement level between anchors of 4 (*Sometimes engaged, sometimes not engaged*) and 7 (*Very engaged*). Mean observed engagement in the compassion group sessions ($M = 5.7$, $SD = 0.71$) did not significantly differ from mean observed

engagement for the active control intervention sessions (M = 6.1, SD = 0.83), $t(20) = 1.08$, p = 0.3, d = 0.49.

Participants self-reported their ability to follow directions during the intervention at 3.3 (SD = 0.70), corresponding to ability to follow directions between "moderately" and "very much" able to follow directions. Participants' self-reported ability to follow directions did not differ between the compassion intervention group (M = 3.38, SD = 0.57) and the active control intervention group (M = 3.17, SD = 0.82), $t(48) = 1.1$, p = .28, d = 0.31. Most participants (n = 36; 72%) reported using a stress-reduction strategy during the TSST-G, while 12 (24%) reported not using a strategy, and 2 (4%) reported that they did not remember. Excluding those who did not remember, a Chi-square test indicated that the exact same number of participants in each condition used (n = 18) and did not use (n = 6) a stress-reduction strategy, $X^2(1, N = 48) = 0.0$, p = 1.0. Of the 36 participants who reported using a strategy, most (n = 22; 61%) reported using a strategy they learned that day, 10 (28%) reported they did not use a strategy they learned that day, and 4 (11%) reported that they did not remember whether they used a strategy they learned that day. Excluding those who did not remember, a Chi-square test indicated no differences between conditions regarding whether participants used a strategy they learned that day, $X^2(1, N = 32) = 0.58$, p = .45.

For the 36 participants who reported using a stress-reduction strategy reported, they reported a mean level of helpfulness of the strategy at 2.58 (SD = 0.65), corresponding to a helpfulness rating between "somewhat" and "moderately" helpful. Participants who used a strategy in the compassion condition (M = 2.61, SD = 0.61) did not significantly differ in their ratings of helpfulness from those in the active control condition (M = 2.56, SD = 0.71), $t(34) = 0.25$, p = 0.80, d = 0.08.

Pre- to Post-Intervention Effects

All post-hoc *t*-tests described in this section were significant at their Benjamini-Hochberg adjusted values. Table 7 describes the fixed effects for the pre- to post-intervention LMMs.

Self-Reported Pre- to Post-Intervention Effects

For state compassion for others, there were not significant main effects for condition (b = -0.15, t = -0.79, p = .44), time (b = -0.03, t = -0.44, p = .66), or gender (b = -0.08, t = -0.62, p = .54). However, there was a significant interaction effect between time and condition (b = 0.21, t = 2.10, p = .04). To visualize this significant interaction, state compassion for others was plotted over time, separated by condition (Figure 5). In the compassion group, state compassion for others increased from baseline (M = 4.12, SD = 0.42) to post-intervention (M = 4.30, SD = 0.38). In the active control intervention group, state compassion for others remained stable from baseline (M = 4.09, SD = 0.48) to post-intervention (M = 4.06, SD = 0.55). A post-hoc *t*-test revealed that state compassion for others significantly increased in the compassion intervention group compared to the active control intervention group with a medium effect size, $t(48) = 2.10$, p = .04, d = 60.

For state self-compassion, there were not significant main effects for condition (b = -0.15, t = -0.70, p = .49), or gender (b = 0.15, t = 0.83, p = .41). However, there was a significant main effect of time (b = 0.45, t = 3.10, p = .003). The interaction between time and condition was not significant (b = 0.29, t = 1.42, p = .16). For the full sample, a post-hoc paired-samples *t*-test demonstrated state self-compassion significantly increased from baseline (M = 3.31, SD = 0.75) to post-intervention (M = 3.91, SD = 0.68), $t(49) = 5.89$; $p < .001$; $d_{rm} = 0.84$.

For state stress, there were not significant main effects for condition (b = -3.76, t = -1.03, p = .31), or gender (b = -1.75, t = -0.72, p = .47). However, there was a significant main effect of

time (b = -4.58, t = -2.29, p = .03). The interaction between time and condition was not significant (b = -3.88, t = -1.40, p = .17). For the full sample, a post-hoc paired-samples t-test demonstrated state stress significantly decreased from baseline (M = 36.40, SD = 12.72) to post-intervention (M = 29.80, SD = 9.10), $t(49)$ = -4.71; $p < .001$; d_{rm} = -0.57.

Physiological Pre- to Post-Intervention Effects

For SBP, there were not significant main effects for condition (b = -4.82, t = -1.73, p = .09), or time (b = 0.03, t = 0.03, p = .98). However, there was a significant main effect of gender (b = 10.36, t = 3.85, $p < .001$). Further, the interaction between time and condition was significant (b = -4.30, t = -2.90, p = .006). To visualize this significant interaction, SBP was plotted over time, separated by condition (Figure 5). In the compassion group, SBP decreased from baseline (M = 114.19, SD = 10.41) to post-intervention (M = 109.92, SD = 9.55). In the active control intervention group, SBP remained stable from baseline (M = 116.13, SD = 11.89) to post-intervention (M = 116.35, SD = 10.96). A post-hoc t-test revealed that SBP significantly decreased in the compassion intervention group compared to the active control intervention group with a large effect size, $t(47)$ = -2.90, p = .006, d = -0.83.

For DBP, there were not significant main effects for condition (b = 0.44, t = 0.20, p = .84), gender (b = -2.02, t = -0.98, p = .20), time (b = -0.12, t = -0.13, p = .97), and the interaction between time and condition was not significant (b = -0.64, t = -0.49, p = .63).

For HR, there were not significant main effects for condition (b = -3.18, t = -1.19, p = .24) or gender (b = -2.88, t = -1.13, p = .27), but there was a main effect of time (b = -4.41, t = -3.61, $p < .001$). The interaction between time and condition was not significant (b = 1.28, t = 0.76, p = .45). For the full sample, a post-hoc paired-samples t-test demonstrated heart rate

significantly decreased from baseline (M = 77.81, SD = 9.58) to post-intervention (M = 74.02, SD = 8.78), $t(48) = -4.54$; $p < .001$; $d_{rm} = -0.41$.

Intervention Effects on Stress Reactivity

All post-hoc t-tests described in this section were significant at their Benjamini-Hochberg adjusted values. Table 8 details the results of the LMMs for stress reactivity. There were not significant main effects for condition for any of the outcomes. However, there was a significant main effect of time and gender in all models. The interaction between time and condition was not significant for SBP reactivity, HR reactivity, or state stress reactivity (Table 8). Post-hoc paired samples t-tests were conducted for SBP, HR, and state stress reactivity using baseline to peak measurements. From baseline to peak stress for the full sample, post-hoc paired-samples t-test demonstrated that on average, SBP significantly increased by 17.6 mmHg (SD = 10.4), $t(49)$ = 11.9, $p < .001$, $d_{rm} = 1.39$, HR increased by 8.52 bpm (SD = 10.6), $t(49) = 5.7$, $p < .001$, d_{rm} = 0.76, and state stress significantly increased by 7.47 units (SD = 14.18), $t(49) = 3.72$; $p < .001$; $d_{rm} = 0.55$.

The interaction between time and condition was significant for DBP reactivity (b = -1.71, t = -2.30, p = .02). To further visualize the interaction between time and condition for DBP reactivity, DBP was plotted over time, separated by condition (Figure 6). In the compassion intervention group, DBP increased from baseline (M = 67.6; SD = 6.9) to peak stress (M = 79.0; SD = 7.1). In the active control intervention group, DBP also increased from baseline (M = 67.7; SD = 7.1) to peak stress (M = 84.0; SD = 7.7). A post-hoc t-test revealed that the increase in DBP from baseline to peak stress was significantly larger in the control intervention group (ΔDBP = 16.2 mmHg) relative to the compassion intervention group (ΔDBP = 11.4 mmHg) with a medium effect size, $t(48) = 2.06$, p = .045, d = 0.59.

For perceptions of TSST-G stressfulness, participants in the compassion intervention group (M = 2.50, SD = 1.14) reported lower perceptions of TSST-G stressfulness compared to those in the active control intervention group (M = 3.04, SD = 0.86), but the difference did not reach statistical significance, $t(48) = -1.89$, $p = .07$, $d = -0.53$.

Sensitivity Analyses

Sensitivity analyses were conducted to understand whether including three participants who completed the in-person portion alone (i.e., not in a group with other participants) influenced intervention effects. These participants were added to the sample, and analyses were conducted again. All significant intervention effects found with the sample of 50 remained significant with the sample of 53. Further, the *t*-test examining whether perceptions of the stressfulness of the TSST-G varied by condition became significant with the additional participants. With 53 participants, those in the compassion group (M = 2.48, SD = 1.12) reported significantly lower perceptions of TSST-G stressfulness compared to those in the active control group (M = 3.04, SD = 0.84), $t(51) = 2.02$, $p = .049$, $d = 0.56$.

Discussion

This study demonstrated that a brief, single-session, group-based compassion intervention significantly increased state compassion for others and significantly reduced SBP from pre- to post-intervention relative to a cognitive reappraisal active control intervention. Both interventions significantly increased state self-compassion and reduced state stress and heart rate from pre- to post-intervention. These findings partially supported my hypotheses that the pre- to post-intervention effects would be greater in the compassion intervention group relative to the active control intervention group. The compassion intervention also attenuated DBP stress reactivity during social-evaluative stress induction relative to the active control intervention.

These findings partially supported my hypothesis that the compassion intervention would attenuate stress reactivity across physiological and self-report variables. Overall, the results from this study indicate that while both brief interventions appear to demonstrate some positive effects, only the compassion intervention attenuated stress reactivity during social-evaluative stress induction.

Results from this study add to a growing literature demonstrating the stress-buffering effects of compassion. Most studies have examined the stress-buffering effects of trait self-compassion or trait compassion for others (Bluth et al., 2016; Breines et al., 2014, 2015; Ceccarelli et al., 2019; Cosley et al., 2010; Ewert et al., 2018; Helminen, Scheer, et al., 2021; Luo et al., 2018). As such, findings from the current project add to the few studies which have examined the effects of a compassion-based intervention on stress reactivity (Arch et al., 2014; Engert et al., 2017; Pace et al., 2009), and extends previous research in several ways. For example, of the extant intervention studies, only one study (Arch et al., 2014) examined the effects of a brief compassion intervention completed individually by participants over the course of several days. The current study is the first to test the effects of a single-session, group-based compassion intervention on stress reactivity, and is the only intervention study in this area to examine blood pressure reactivity. This study also extends on Arch et al.'s (2014) work by including a mixed-gender sample instead of only including women, which provides more confidence in the generalization of stress-buffering effects of compassion interventions to multiple genders.

Research Implications

The findings that both interventions significantly increased self-compassion provide important implications for intervention science. Reviews of mindfulness-based interventions

have identified that increased self-compassion may be a mechanism by which these interventions are effective (Baer, 2010; Golden et al., 2021), even though mindfulness-based programs are usually multifaceted (i.e., include many components) and do not always focus explicitly on compassion practice. Given results of the present study demonstrating that cognitive reappraisal training increased self-compassion, improving self-compassion might also be a mechanism underlying the effectiveness of cognitive reappraisal. There is considerable research on the benefits of cognitive reappraisal training on mental health (Boemo et al., 2022; Buhle et al., 2014; Hu et al., 2014; Kvillemo & Bränström, 2014), and it is thought to be one of reasons why CBT is so effective (Clark, 2022).

Significant results for DBP reactivity but not the other stress indices could be due to several reasons. Similar to the pre- to post-intervention data which demonstrated similar gains in state self-compassion and similar reductions in HR after both interventions, it is possible that both interventions were effective for reducing SBP and HR reactivity. Without a no training control group to which we could compare SBP and HR reactivity, it remains unknown whether these interventions did indeed reduce reactivity. However, for HR reactivity to the TSST-G, other studies without an intervention component have reported increases of 38.3 – 47.9 bpm, whereas participants' HR in this study increased by only 8.5 bpm on average. While these results are not directly comparable given various potential confounding differences between studies, it provides some indication that both interventions may have reduced HR reactivity in this study. To my knowledge, no other TSST-G studies have examined SBP reactivity, though increases in SBP in this study were similar to previous individual TSST research (Kupper et al., 2021). However, prior research comparing the TSST to the TSST-G found greater increases in HR

reactivity in the group condition, indicating that the present study may not be comparable to individual TSST studies.

Another reason for significant DBP results, but not others, could be related to whether and how participants implemented strategies learned in the compassion intervention. For instance, if participants attempted to use soothing rhythm breathing (see Appendix A) during the TSST-G, this strategy could have influenced DBP but not other variables. A recent study which examined different patterns of breathing (e.g., 4.5 second inhale and 4.5 second exhale vs 6 second inhale and 2 second exhale) found that a pattern of breathing similar to soothing rhythm breathing reduced both SBP and DBP by 3.7 mmHg, which, due to the difference in scale for SBP and DBP, amounted to 3.3% drop in baseline SBP and a 5.0% drop in baseline DBP (Herakova et al., 2017). While researchers did not examine whether these decreases significantly differed from one another, it is possible that strategies participants employed from the compassion training in the present study may have differentially affected outcome variables (i.e., influenced DBP more than SBP reactivity). Additional research on differential outcomes related to DBP and SBP could be helpful in clarifying the intervention effects found in this study.

Clinical Implications

This study provides important clinical implications for service providers who work with young adult populations. Compared to the active control intervention group, SBP for participants in the compassion group decreased by 4.3 mmHg on average from pre- to post-intervention. For context, blood pressure medications (e.g., statins) reduce SBP by 2.2 to 3.3 mmHg on average (Bautista, 2009; Golomb et al., 2008). While reductions from pre- to post-intervention in this study were likely state effects rather than sustained reductions in blood pressure (Russo et al., 2017), it is possible that regular compassion practice, and in turn, regular short-term reductions

in SBP, may be beneficial to one's overall long-term heart health. A recent meta-analysis demonstrated that another brief intervention (i.e., a single 30-50-min session of aerobic exercise) produced short term reductions in SBP (reduction of 2.2 mmHg), and researchers hypothesized that repeated short-term reductions in blood pressure due to regular exercise may underlie the generalized blood pressure-lowering effects of exercise (Saco-Ledo et al., 2021). Repeated short-term reductions in SBP due to regular compassion practice may have similar effects, though more long-term intervention research is needed to test this hypothesis.

Given the brief nature of the intervention used in this study, compassion training may be easily implemented into a variety of practice settings, including college counseling centers and primary care environments as a brief stress management intervention (Amanvermez et al., 2020; Collings et al., 2015). The brevity and group delivery of the compassion intervention in this study also provides benefits such that clinicians may increase their impact by working briefly with multiple clients at a time. This may be particularly important in college counseling contexts, where demand for services is consistently increasing (Lipson et al., 2019). Results from this study may warrant the implementation of compassion training groups for college students, particularly with the script included in Appendix A of this document or the full-length version of the compassion intervention developed for college students from which the brief intervention was adapted (Cattani et al., 2021).

The attenuated DBP reactivity demonstrated in the compassion group in this study has important clinical implications for cardiovascular disease prevention and coping during stress. Numerous studies have demonstrated that high DBP reactivity in young adults predicts hypertension and coronary artery calcification later in life (Carroll et al., 2001, 2011; Matthews et al., 2004, 2006). Results from this study indicate that incorporating practicing compassion

during emerging adulthood may reduce DBP reactivity, and in turn, this may protect against the development of cardiovascular disease.

Young adults, particularly those attending college, are often in social-evaluative situations that elicit fear of negative evaluation (Cooper et al., 2018; Downing et al., 2020). Results from the current study indicate that practicing compassion prior to or during social-evaluative stress can partially mitigate the physiological stress reactions. Moreover, elevated DBP reactivity to stress is associated with decreased cognitive performance on working memory and executive functioning tasks (J. P. Brown et al., 2009; Waldstein & Katzel, 2005). Thus, attenuating DBP reactivity through compassion practice may be effective for young adults' performance in social-evaluative situations, particularly in situations that require working memory and executive functioning (e.g., oral examinations).

Limitations and Future Directions

While this study provides novel findings which highlight the potential of brief compassion-based and cognitive reappraisal training interventions, there are also numerous limitations. This study targeted young adults due to the increased stress and increased mental health concerns during emerging adulthood (APA, 2020; R. D. Goodwin et al., 2020; Huckins et al., 2020; Sutin et al., 2013), along with the potential for preventing cardiovascular disease during emerging adulthood through reducing stress reactivity (Carroll et al., 2001, 2011; Matthews et al., 2004, 2006). However, the sample in this study consisted of young adults at a private university, many of whom reported household incomes of over $100,000. Thus, it remains unknown whether these results may generalize to young adults attending community colleges, trade schools, are in the workforce, or who are from low-income households. Future studies should examine whether compassion-based interventions are effective for young adults in

settings other than a private university, along with low-income young adults. Further, future studies should test brief compassion training with additional age groups, as longer (e.g., 8-week) compassion-based interventions have demonstrated positive effects for children, adolescents, and adults (Bluth & Eisenlohr-Moul, 2017; Flook et al., 2015; Seekis et al., 2022).

The population included in this study was also limited in that all participants were cisgender, and most were heterosexual. Further, while the sample was fairly diverse across racial/ethnic identity, some Black, Indigenous, and People of Color (BIPOC) subgroups were not represented or were underrepresented (e.g., no American Indian/Alaska Native people screened into the study). Sexual and gender minority and BIPOC young adults are under greater stress, including stigma-related stress, and experience more mental health symptoms than cisgender, heterosexual young adults (M. Berger & Sarnyai, 2015; Bissonette & Szymanski, 2019; Borgogna et al., 2019; Chin et al., 2020; J. M. Cohen et al., 2016; Winberg et al., 2019; Woodford et al., 2014). Sexual and gender minority people and several BIPOC subgroups (e.g., Black/African American people, American Indian/Alaska Native people) also report more cardiovascular disease than cisgender heterosexual people and white people, respectively (Caceres et al., 2020; Centers for Disease Control and Prevention, 2014; Rice et al., 2019; Tajeu et al., 2020). These studies indicate that sexual and gender minority and BIPOC people at risk for adverse cardiovascular outcomes may benefit from stress-buffering interventions, such as compassion training. Research also indicates that stigma exposure among sexual minority and BIPOC people influences cardiovascular stress reactivity (Juster et al., 2019; Sawyer et al., 2012), which may underlie documented health disparities across sexual identity and racial/ethnic identity. Thus, stigmatized sexual and gender minority and BIPOC people may benefit from stress-buffering interventions which target stress reactivity. Future research should seek to

extend the results from this study to sexual and gender minority and BIPOC people, particularly for BIPOC subgroups at risk for cardiovascular disease (Centers for Disease Control and Prevention, 2014; Tajeu et al., 2020).

Another limitation of this study was that I only measured stress reactivity with cardiovascular and self-report variables. While cardiovascular indices of stress reactivity are associated with cardiovascular and mental health outcomes (Carroll et al., 2011; Matthews et al., 2004; Shahimi et al., 2022), a large body of research has demonstrated that HPA axis indices of stress reactivity (e.g., cortisol) are also extremely important predictors of mental and physical health (Taylor, 2010; Turner et al., 2020). Future studies should include HPA axis measurements, such as cortisol, to examine whether compassion-based training may influence stress reactivity across these physiological domains. Prior stress induction research has also demonstrated reductions in cognitive functioning (e.g., lower performance on executive functioning tasks) after experiencing social-evaluative stress (Shields et al., 2016). Future research could also incorporate cognitive functioning outcomes to understand whether compassion training may be effective at buffering against stress-related reductions in executive functioning.

This study investigated the immediate outcomes of a brief compassion intervention, but it was limited by not including follow-up data to determine longer-term effects. Whether brief compassion training may generate sustained increases in compassion and self-compassion and sustained reductions in stress reactivity remains unknown. Future studies should include additional time points to identify long-term effects of brief compassion training. This study also used a laboratory-based stressor, which allows for standardization of procedures across participants. However, laboratory assessments manufacture stressful situations and may not

generalize to daily stress events. Thus, future studies should use more ecologically valid methods, such as experience sampling (Gordon & Mendes, 2021), to understand whether brief compassion training reduces stress reactivity to participant's daily stressors.

The inclusion of an active control intervention allowed for establishing comparative efficacy between the brief compassion intervention and the active control intervention. However, without a no training control group, it remains unknown whether both interventions may have been effective in reducing HR, SBP, or state stress reactivity relative to no training. It is possible that both were effective in stress-buffering across these variables and simply did not differ between each other. Future intervention studies could include a no training control group in addition to compassion and cognitive reappraisal training to examine whether both interventions may have been effective for SBP, HR, and subjective stress reactivity. Further, because the compassion intervention included both mind and body approaches, it is unclear which components and/or to what extent each component may be contributing to the intervention effects. Future studies could compare compassion training with and without a body-based practice (i.e., compassion training with soothing rhythm breathing vs. compassion training without soothing rhythm breathing) to understand the extent to which body-based practices may be an active ingredient in compassion training. Another consideration is that the power analysis for this study indicated that it may be slightly underpowered. However, the power analysis originally estimated a clustering of three participants per group, whereas average group size in the study was slightly smaller than three participants per group, which would increase the estimated power. Regardless, data from this study could be used as pilot data for future studies which incorporate more participants and additional conditions to provided further confidence in effects and clarify active ingredients.

Another methodological limitation to this study was the inability mask condition assignment for the interventionist or participants, which is a commonly cited issue in contemplative intervention research (Davidson & Kaszniak, 2015). While there were areas in which masking was possible (e.g., TSST-G panelists were masked to condition), both myself as the interventionist and the participants were aware of the condition assignment. Further, although including fidelity coding and having the same interventionist for all sessions may have standardized the delivery, there is the possibility that common factors (e.g., therapeutic alliance, empathy) related to the interventionist may contribute to purported intervention effects (J. Brown, 2015; Wampold, 2015). Future studies might consider having multiple interventionists balanced across conditions and examine whether intervention effects may vary by interventionist.

While the goal of this study was to establish whether brief compassion training may be non-inferior or superior to cognitive reappraisal training, future studies should also examine for whom and in what context compassion interventions may be most effective. For example, several studies have demonstrated that both gender and trait levels of compassion influence stress reactivity (Breines et al., 2015; Ewert et al., 2018; Helminen, Scheer, et al., 2021; Luo et al., 2018). Other research has indicated that those who exhibit the largest increases in stress in response to a stressor have worse cardiovascular outcomes later in life relative to those who exhibit smaller increases in stress (Radtke et al., 2013; Zhao et al., 2015). Future studies could identify moderators of treatment effects and target populations for whom the compassion training may be most effective.

Given that both compassion training and cognitive reappraisal training increased state self-compassion from pre- to post-intervention, future studies which implement cognitive

reappraisal training could include self-compassion to examine whether self-compassion may as a mediator between cognitive reappraisal training and improvements in mental health. If self-compassion is indeed found to be a mechanism of change underlying a variety of interventions (e.g., cognitive reappraisal, mindfulness), this could warrant prioritizing self-compassion as an intervention target, particularly if there are additional benefits to explicitly focusing on compassion training, like reductions in stress reactivity identified in this study.

Conclusion

This study found that a brief, group-based compassion training with young adults demonstrated pre- to post-intervention increases in state compassion for other and decreases in SBP compared to cognitive reappraisal training, while both interventions demonstrated increases in self-compassion and reductions in HR from pre- to post-intervention. The compassion intervention also demonstrated reduced DBP reactivity to a group-based social-evaluative stressor compared to cognitive reappraisal training. These results indicate that brief compassion training may be a promising strategy implement regularly to reduce SBP, and it may be an effective stress-buffering intervention for young adults experiencing acute social-evaluative stress. Findings also indicate that compassion training may be an important health behavior to implement during emerging adulthood to protect against the development of cardiovascular disease later in life. These results provide impetus for incorporating compassion training in settings which serve young adults, such as college counseling centers.

Tables and Figures

Table 1

Effects of Trait Compassion on Stress Reactivity

		Stress Reactivity Measures		
Study	Participants	Self-Report	Physiological	Trait Compassion Outcomes
Bluth et al., (2016)	Adolescents *n* = 28	STAI	Cortisol HR SBP DBP HRV	Stress reactivity measured via all variables demonstrated no significant differences between high and low levels of self-compassion
Breines et al., (2015)	Young adults *n* = 33	None	sAA	sAA reactivity was significantly lower in participants with higher self-compassion for both initial exposure to TSST and repeated exposure the next day
Breines et al., (2014)	Young adults *n* = 41	None	IL-6	IL-6 reactivity was significantly lower in participants with higher self-compassion for initial exposure to TSST IL-6 reactivity demonstrated no significant differences between high and low self-compassion groups to second TSST exposure on Day 2 Note: Although self-compassion did not predict lower levels of IL-6 reactivity on Day 2, the starting baseline level of IL-6 on Day 2 was significantly lower for the higher self-compassion group
Ceccarelli et al., (2019)	University or national-level athletes *n* = 91	Maladaptive thoughts Negative affect	HRV	Trait self-compassion was negatively associated with stress reactivity measured via maladaptive thoughts, negative affect, and HRV

Cosley et al. (2010)	Community sample of adults *n* = 59	None	SBP DBP Cortisol HRV	In the neutral condition, participants with high compassion for others exhibited no differences in SBP, DBP, cortisol, or HRV to the stress test relative to those who reported low levels of compassion for others In the social support condition, participants with high compassion for others exhibited reduced stress reactivity relative to those who reported low levels of compassion as measured by SBP, DBP, cortisol, and HRV
Ewert et al., (2018)	Young adults *n* = 105	VAS for perceived stress	None	Self-reported stress reactivity was significantly lower in participants with higher self-compassion
Helminen et al. (2021)	Young adults *n* = 137	PSRS	None	Self-reported stress reactivity was negatively associated with self-compassion
Luo et al., (2018)	Healthy Asian men *n* = 34	Negative affect	HR HRV	Heart rate reactivity demonstrated no significant differences between the high self-compassion group and the low self-compassion group Stress reactivity measured via HRV was significantly lower in participants with higher self-compassion Stress reactivity measured via negative affect was significantly lower in participants with higher self-compassion

Note. HR = heart rate; SBP = systolic blood pressure; DBP = diastolic blood pressure; HRV = heart rate variability; STAI-6 = shortened State Trait Anxiety Inventory; sAA = salivary alpha-amylase; TSST = Trier Social Stress Test; IL-6 = interleukin 6; PSRS = perceived stress reactivity scale; VAS = visual analog scale.

Table 2

Effects of Compassion-Based Contemplative Interventions on Stress Reactivity

		Stress Reactivity Measures		
Study	Participants	Self-Report	Physiological	Compassion Intervention Outcomes
Arch et al., (2014)	Young adult women *n* = 105	SUDS	Cortisol sAA RSA	Cortisol reactivity was not significantly different between compassion group and control groups sAA reactivity was significantly lower for compassion group compared to control groups RSA reactivity during speech preparation task was stable in compassion group and significantly increased in the control group RSA reactivity during speech and math tasks demonstrated no significant differences between self-compassion group and control groups Self-reported stress reactivity measured via the SUDS was significantly lower for the self-compassion group compared to both control groups
Engert et al., (2017)	Community volunteers *n* = 313	STAI-6	Cortisol sAA HR HRV CRP IL-6	Cortisol reactivity was significantly lower for the 3-month Affect Only (i.e., compassion practice) group compared to the control group Stress reactivity measured via sAA, HR, HRV, CRP, and IL-6 demonstrated no significant differences for any of the contemplative intervention groups compared to the control group Self-reported stress reactivity measured via STAI was significantly lower in all contemplative intervention groups compared to the control group
Pace et al., (2009)	Young adults *n* = 61	POMS	Cortisol IL-6	Cortisol and IL-6 stress reactivity were not significantly different for the compassion group compared to the control group Self-reported stress reactivity measured via the POMS were not significantly different between compassion group and control group Increased practice in compassion group was correlated with decreased TSST induced IL-6 and POMS distress scores.

Note. sAA = salivary alpha-amylase; RSA = respiratory sinus arrythmia; SUDS = subjective units of distress; HR = heart rate; HRV = heart rate variability; CRP = C-reactive protein IL-6 = interleukin 6; STAI-6 = shortened State Trait Anxiety Inventory; POMS = Profile of Mood States; TSST = Trier Social Stress Test.

Table 3

Model Selection for Pre- to Post-Intervention Linear Mixed Models

	Model Information			Model Fit Criteria			Likelihood Ratio Test		
Dependent Variable	Name	Number	*df*	AIC	BIC	LL	Models	L Ratio	*p*
State Compassion for Others	FE	1	6	150.87	166.19	-69.43	–	–	–
	FE + Intercept	2	7	118.10	135.98	-52.05	1 vs 2	34.77	**<.001**
	FE + Intercept and Slope	3	9	122.03	145.01	-52.01	2 vs 3	0.07	.97
State Compassion for Others	FE	1	6	235.14	250.46	-111.57	–	–	–
	FE + Intercept	2	7	222.60	240.48	-104.30	1 vs 2	14.54	**<.001**
	FE + Intercept and Slope	3	9	225.93	248.91	-103.96	2 vs 3	0.67	.71
Systolic Blood Pressure	FE	1	6	717.34	732.60	-352.67	–	–	–
	FE + Intercept	2	7	658.50	676.30	-322.25	1 vs 2	60.84	**<.001**
	FE + Intercept and Slope	3	9	661.06	683.95	-321.53	2 vs 3	1.44	.49
Diastolic Blood Pressure	FE	1	6	670.27	685.53	-329.13	–	–	–
	FE + Intercept	2	7	621.17	638.97	-303.58	1 vs 2	51.10	**<.001**
	FE + Intercept and Slope	3	9	624.14	647.03	-303.07	2 vs 3	1.03	.60
Heart Rate	FE	1	6	708.89	724.14	-348.44	–	–	–
	FE + Intercept	2	7	665.43	683.23	-325.72	1 vs 2	45.45	**<.001**
	FE + Intercept and Slope	3	9	668.98	691.87	-325.49	2 vs 3	0.45	.80
State Stress	FE	1	6	747.30	762.63	-367.65	–	–	–
	FE + Intercept	2	7	729.82	747.70	-357.91	1 vs 2	19.48	**<.001**
	FE + Intercept and Slope	3	9	720.42	743.41	-351.21	2 vs 3	13.40	**.001**

Note. FE = general linear model with fixed effects only; FE + Intercept = linear mixed model with random effects for intercept; FE + Intercept + Slope = linear mixed model with random effects for intercept and slope; AIC = Akaike information criterion; BIC = Bayesian information criterion; LL = log likelihood. Specifications for each model are as follows: FE = gender + time*condition; FE + Intercept = gender + time*condition + (1 | participant); FE + Intercept + Slope = gender + time*condition + (time | participant)

Table 4

Model Selection for Stress Reactivity Linear Mixed Models

	Model Information			Model Fit Criteria			Likelihood Ratio Test		
Dependent Variable	Name	Number	*df*	AIC	BIC	LL	Models	L Ratio	*p*
Systolic Blood Pressure	FE	1	6	1456.63	1476.05	-722.31	–	–	–
	FE + Intercept	2	7	1397.31	1419.96	-691.65	1 vs 2	61.32	**<.001**
	FE + Intercept and Slope	3	9	1400.51	1429.64	-691.26	2 vs 3	0.79	.67
Diastolic Blood Pressure	FE	1	6	1364.92	1384.34	-676.46	–	–	–
	FE + Intercept	2	7	1309.92	1332.57	-647.96	1 vs 2	57.01	**<.001**
	FE + Intercept and Slope	3	9	1313.25	1342.38	-647.63	2 vs 3	0.66	.72
Heart Rate	FE	1	6	1466.27	1485.69	-727.13	–	–	–
	FE + Intercept	2	7	1402.52	1425.17	-694.26	1 vs 2	65.75	**<.001**
	FE + Intercept and Slope	3	9	1402.04	1431.17	-692.02	2 vs 3	4.48	.11
State Stress	FE	1	6	1180.24	1198.10	-584.12	–	–	–
	FE + Intercept	2	7	1173.03	1193.87	-579.52	1 vs 2	9.21	**.002**
	FE + Intercept and Slope	3	9	1177.03	1203.82	-579.52	2 vs 3	0.00	1.0

Note. FE = general linear model with fixed effects only; FE + Intercept = linear mixed model with random effects for intercept; FE + Intercept + Slope = linear mixed model with random effects for intercept and slope; AIC = Akaike information criterion; BIC = Bayesian information criterion; LL = log likelihood. Specifications for each model are as follows: FE = gender + time*condition; FE + Intercept = gender + time*condition + (1 | participant); FE + Intercept + Slope = gender + time*condition + (time | participant); Slope Only = Intercept and Slope = gender + time*condition + (time – 1 | participant)

Table 5

Sample Characteristics by Condition (N = 50)

	Compassion Group (*n* = 26)		Active Control Group (*n* = 24)		Comparison Statistics	
Variable	*n*	%	*n*	%	X^2	*p*
Gender[a]					3.89	**.049**
Cisgender women	9	34.6	15	62.5		
Cisgender men	17	65.4	9	37.5		
Race/Ethnicity[a]					1.53[c]	.22
Asian	3	11.5	9	37.5		
Black/African American	4	15.4	4	16.7		
Latina/Latino/Latinx	3	11.5	1	4.2		
Middle Eastern	1	3.8	0	0.0		
Multiracial	3	11.5	3	12.5		
White	12	46.2	7	29.2		
Sexual Identity[a]					0.06[d]	.81
Bisexual/pansexual	2	7.7	1	4.2		
Lesbian	0	0.0	1	4.2		
Gay	0	0.0	2	8.3		
Questioning/unsure	2	7.7	0	0.0		
Straight/heterosexual	21	80.8	20	83.3		
Multiple identity labels	1	3.8	0	030		
Household Income[b]					0.04[e]	.85
<$10,000	1	3.8	1	4.2		
$10,000-$24,999	3	11.5	3	12.5		
$25,000-$49,999	2	7.7	1	4.2		
$50,000-$74,999	3	11.5	3	12.5		
$75,000-$99,999	3	11.5	2	8.3		
>$100,000	14	53.8	14	58.3		
	M	*SD*	*M*	*SD*	*t*	*p*
Age	19.2	1.0	19.0	1.1	0.53	.60
Intervention group size	3.2	1.0	2.9	1.1	0.95	.35

Note. M = mean; SD = standard deviation.

[a] Additional gender identities (e.g., transgender, non-binary), races/ethnicities (e.g., American Indian/Alaskan Native), and sexual identities (e.g., asexual) were assessed for but not reported by any participants, and are not included in this table.

[b] Household income included parent/caregiver income if participants were predominantly supported by parents/caregivers.

[c] Chi-square test was conducted with participants collapsed into participants of Color vs. white participants due to small cell counts

[d] Chi-square test was conducted with participants collapsed into sexual minority participants vs heterosexual participants due to small cell counts

[e] Chi-square test was conducted with participants collapsed into household incomes of <$50,000 vs. ≥$50,000 due to small cell counts

Table 6

Pearson's r Correlations and Descriptive Statistics for Continuous Variables at Baseline

Variable	1	2	3	4	5	6	7	8
1. Age	–							
2. Group Size	.06	–						
3. State Compassion for Others	-.02	-.01	–					
4. State Self-Compassion	-.05	-.23	.45**	–				
5. State Stress	-.03	.22	-.30*	-.58**	–			
6. Systolic Blood Pressure	-.06	-.01	-.20	-.08	.13	–		
7. Diastolic Blood Pressure	.32*	.20	-.02	-.16	.12	.53**	–	
8. Heart Rate	.20	.20	.09	-.15	.04	-.08	.34**	–
Mean	19.1	3.02	4.1	3.3	36.4	115.1	67.7	77.6
SD	1.03	1.04	0.45	0.75	12.7	11.1	7.0	9.6

Note. SD = standard deviation; *$p < .05$; **$p < .01$

Table 7

Fixed Effects in Linear Mixed Models for Pre- to Post-Intervention Analyses

Self-Report Variables												
	State Compassion for Others				State Self-Compassion				State Stress			
		95% CI				95% CI			*B*	95% CI		*p*
Variable	*B*	LL	UL	*p*	*B*	LL	UL	*p*		LL	UL	
Gender	-0.08	-0.32	0.17	.54	0.15	-0.21	0.51	.41	-1.75	-6.64	3.13	.47
Time	-0.03	-0.17	0.11	.66	0.45	0.17	0.74	**.003**	-4.58	-8.61	-0.56	**.03**
Condition	0.05	-0.21	0.32	.69	-0.15	-0.55	0.26	.49	-3.76	-11.10	3.57	.31
Time × Condition	0.21	0.01	0.40	**.04**	0.29	-0.11	0.68	.16	-3.88	-9.46	1.71	.17
Physiological Variables												
	Systolic Blood Pressure				Diastolic Blood Pressure				Heart Rate			
		95% CI				95% CI				95% CI		
Variable	*B*	LL	UL	*p*	*B*	LL	UL	*p*	*B*	LL	UL	*p*
Gender	10.36	4.95	15.77	**<.001**	-2.02	-6.19	2.15	.33	-2.88	-8.01	2.26	.27
Time	0.03	-2.14	2.20	.98	-0.12	-2.01	1.77	.90	-4.41	-6.87	-1.95	**<.001**
Condition	-4.82	-10.42	0.78	.09	0.44	-3.92	4.80	.84	-3.18	-8.58	2.21	.24
Time × Condition	-4.30	-7.28	-1.32	**.006**	-0.64	-3.24	1.97	.63	1.28	-2.10	4.66	.45

Note. B = unstandardized beta coefficient; CI = confidence interval; LL = lower limit; UL = upper limit. Bold indicates significant *p*-value.

Table 8

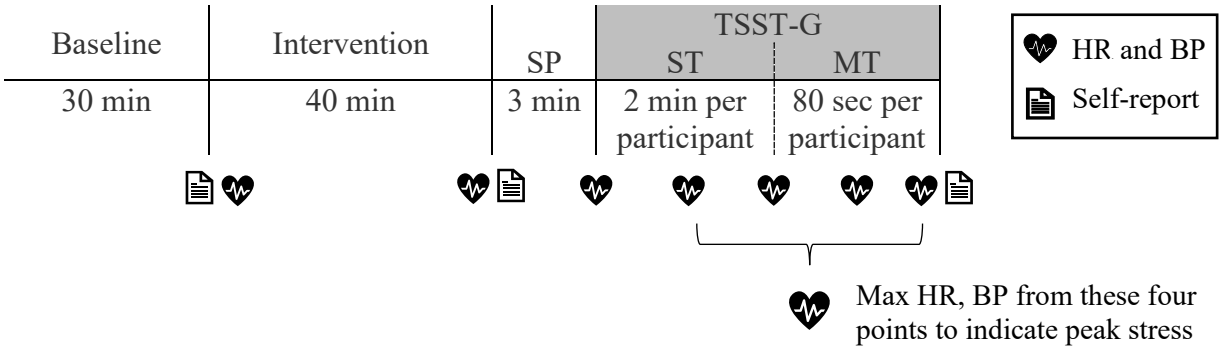
Fixed Effects in Linear Mixed Models for Stress Reactivity Analyses

	Systolic Blood Pressure				Diastolic Blood Pressure				Heart Rate				State Stress			
		95% CI				95% CI			*B*	95% CI		*p*	*B*	95% CI		*p*
Variable	*B*	LL	UL	*p*	*B*	LL	UL	*p*		LL	UL			LL	UL	
Gender	11.49	6.34	16.63	**<.001**	0.11	-3.85	4.06	.96	-3.08	-8.42	2.26	.25	-5.58	-10.97	-0.18	**.04**
Time	6.27	4.95	7.60	**<.001**	5.72	4.65	6.78	**<.001**	2.99	1.66	4.33	**<.001**	3.33	0.21	6.46	**.04**
Condition	-6.59	-12.43	-0.75	**.03**	0.16	-4.37	4.70	.94	-2.64	-8.66	3.38	.38	-4.25	-11.20	2.71	.23
Time × Condition	-0.27	-2.10	1.57	.77	-1.71	-3.18	-0.24	**.02**	-0.15	-2.00	1.70	.87	0.77	-3.56	5.10	.73

Note. B = unstandardized beta coefficient; CI = confidence interval; LL = lower limit; UL = upper limit. Bold indicates significant *p*-value.

Figure 1

Timeline and Points of Measurement throughout the Experiment



Note. The self-reports consist of state compassion (for the first two time points) and state stress. TSST = Trier Social Stress Test; SP = speech preparation; ST = speech task; MT = math task; HR = heart rate; BP = blood pressure, including both systolic and diastolic blood pressure.

Figure 2

Trellis Plots Demonstrating Variability Across Participants in Intercept and Slope for Diastolic Blood Pressure Reactivity

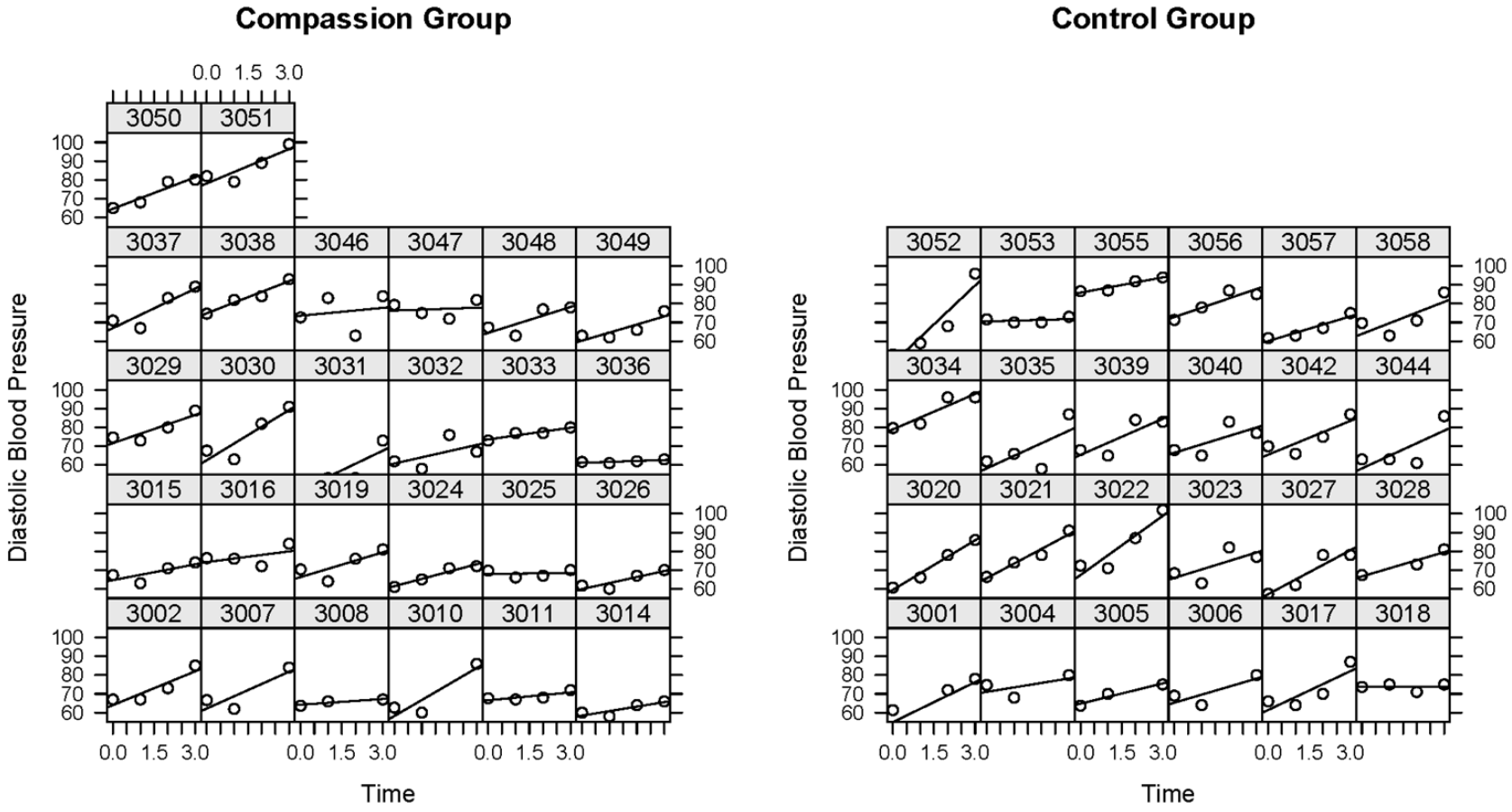


Figure 3

Boxplots Demonstrating Variability Across Participants in Intercept and Slope for Diastolic Blood Pressure Reactivity

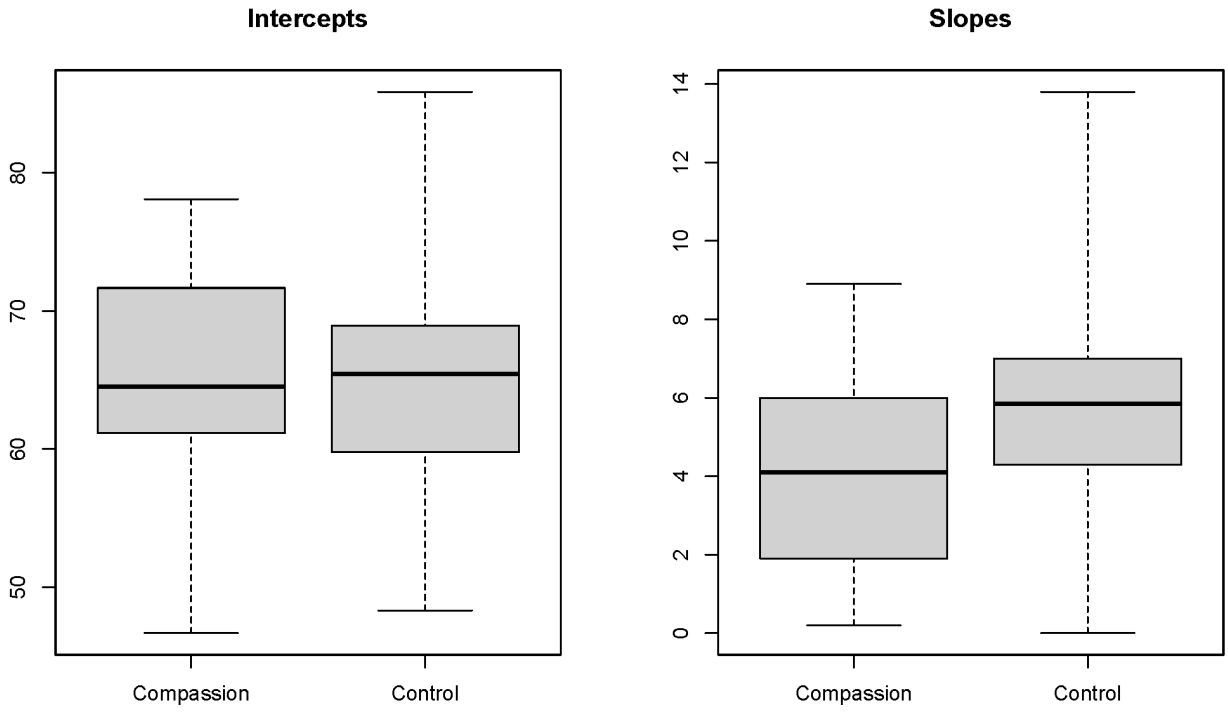
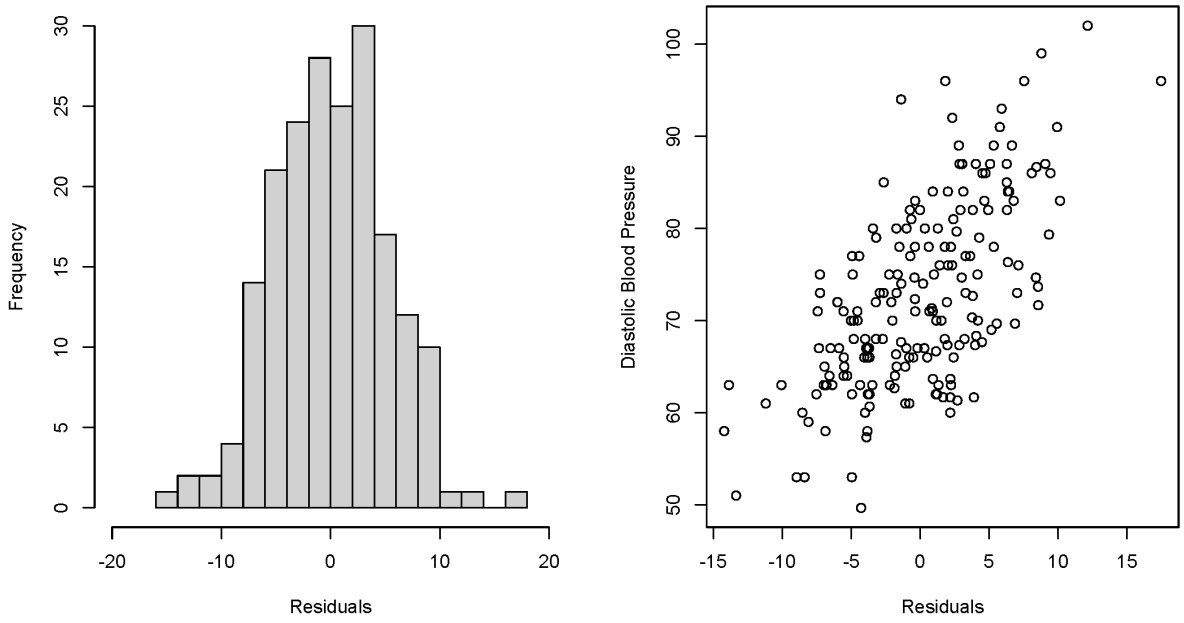


Figure 4

Diagnostic Plots Assessing Normality (upper left), Linearity (upper right), and Constant Variance (bottom) for Diastolic Blood Pressure Reactivity



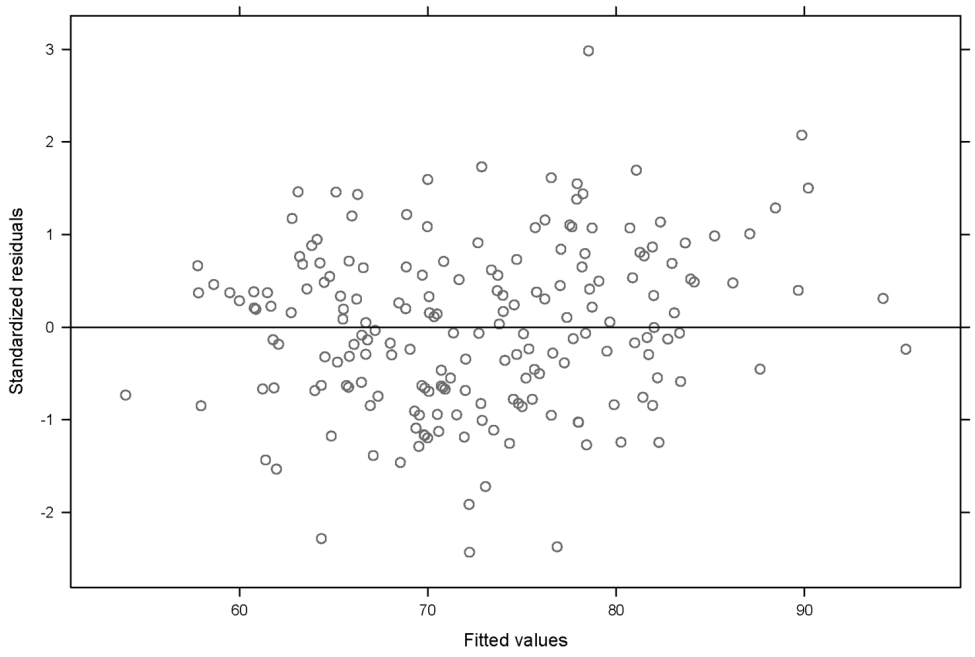
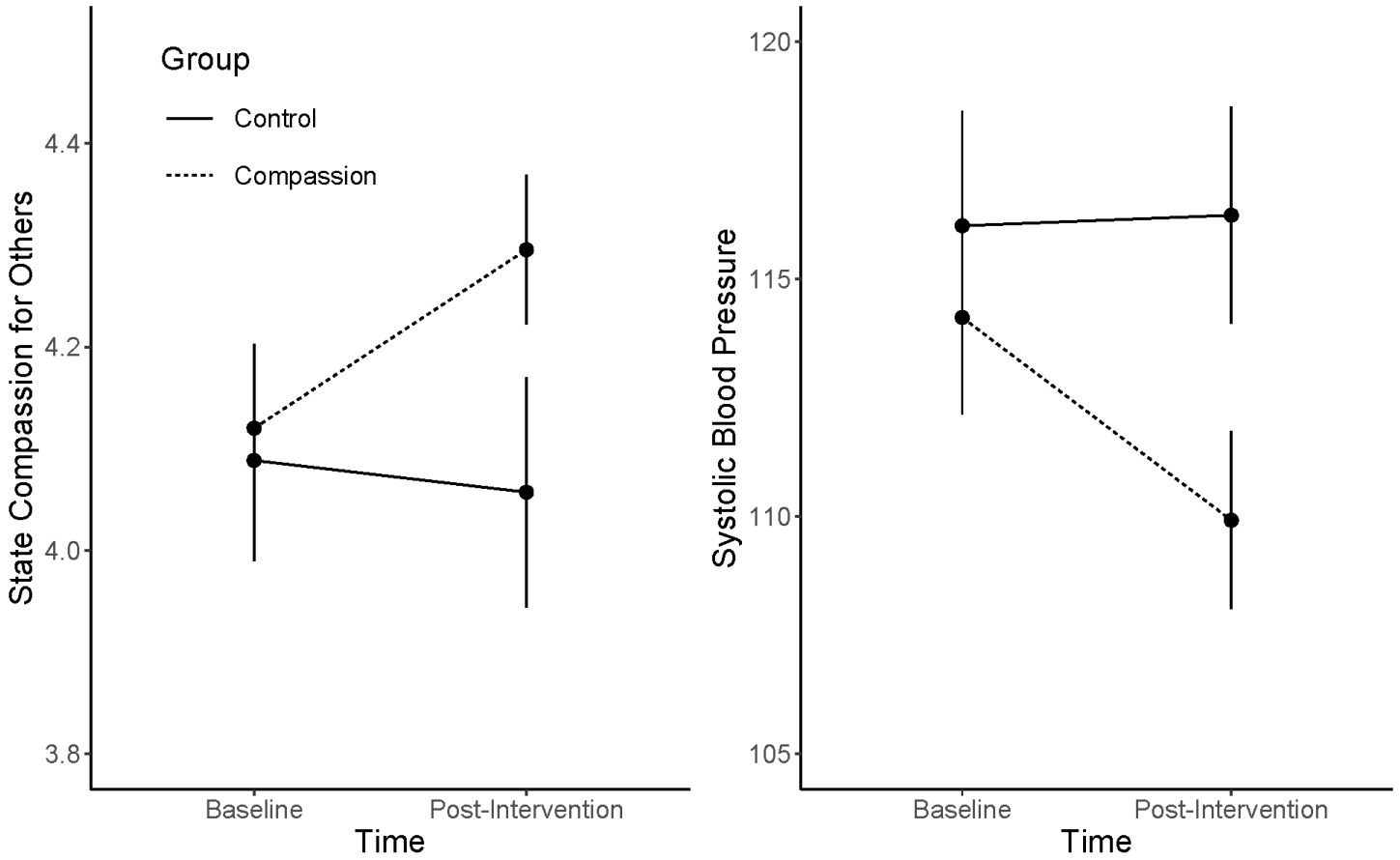


Figure 5

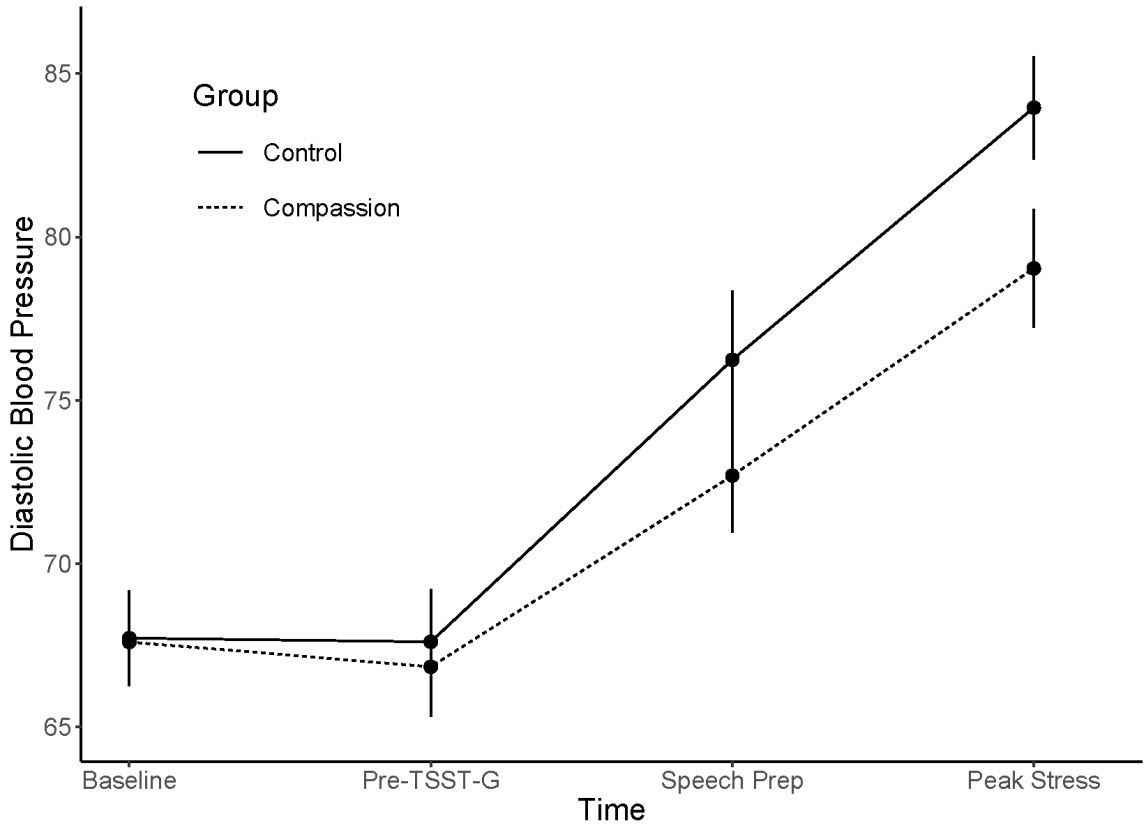
Pre- to Post-Intervention Effects on State Compassion for Others (left) and Systolic Blood Pressure (right)



Note. Error bars represent ±1 standard error of the mean.

Figure 6

Intervention Effects on Diastolic Blood Pressure Reactivity



Note. Error bars represent ±1 standard error of the mean.

Appendix A

Compassion Intervention

Opening Practice (5 Minutes)

0:00
Settling:
Today we're going to be learning how to practice compassion, both for others and for ourselves. Let's begin today with a short practice before we talk more about what it means to practice compassion.

Get comfortable in your chairs, feet flat on the floor, sitting upright, shoulders back, and chest open. If you're comfortable, gently close your eyes or just direct your gaze downwards.

Start to slow your breathing a little and settle into your mind and body.

(pause)

1:00
Soothing Rhythm Breathing
Now, let's focus on soothing rhythm breathing. I will count you into this. For those of you who find counting distracting, feel free to just work on slowing your breath to an even, slow, comfortable rhythm. For those of you for whom counting is helpful, here we go:

Breathing in 2…3…4…5 and out 2…3…4…5

In 2…3…4…5 and out 2…3…4…5

As you develop your rhythm, notice and focus on the feeling of inner slowing with each out breath. Gradually get that sense of grounding—a sense of stilling and slowing while maintaining an alert mind. Notice yourself becoming more grounded.

On each alternate out breath, say with a friendly supportive voice silently to yourself:

Body slowing down

Mind slowing down

2:30
Redirecting:
Sooner or later (usually sooner), your mind may wander to thoughts, planning, daydreams, drifting along—whatever. This is perfectly OK—it's simply what minds do. It is not a mistake or a failure. When you notice that your mind is wandering, feel free to continue counting the in-breaths and out-breaths.

Breathing in 2…3…4…5 and out 2…3…4…5

In 2…3…4…5 and out 2…3…4…5

On each alternate out breath, say with a friendly supportive voice silently to yourself:

Body slowing down

Mind slowing down

4:00
Closing:
As you feel ready, start to let go of the soothing rhythm breathing. Start to slowly to come back to the room, noticing your body in the chair, feet on the ground, the sounds in the room. And when you feel ready, you can open your eyes.

4:30
Questions:
Are there any questions you have, or reactions to that practice you would like to share?

(pause for questions/reactions)

Didactic Instruction (10 Minutes)

0:00
Intro to compassion:
That was the first of two practices that we will be doing together today. We are going to take the next few minutes discussing the practice we just did and how it relates to the next one. This practice was all about learning how to tap into our soothing system to help us feel calmer.

When we feel calm, we are able to practice compassion more easily for ourselves and others than when we feel upset or agitated. The activity we will be doing later on will be practicing compassion.

Understanding compassion:
First, it is useful for us to think about what we mean when we use the word compassion. You probably have your own insights as to what compassion is. To help you recognize that you already have an understanding of compassion, I want you to go ahead and slow your breath for just a moment and if you're comfortable, close your eyes and bring an event to mind in which you helped someone who was struggling.

(pause)

As you're doing this, don't focus too much on their distress, but rather on what was happening for you. Go ahead and allow yourself to reflect on this for a moment.

(pause)

When you're ready, you can open your eyes if they were closed.

What was going on in your mind? What were you thinking?

What were you feeling? What did you want to do?

(pause to wait for responses)

3:00

Definition of compassion:

Compassion is often defined as "Sensitivity to suffering and distress in self and others with a commitment to try to alleviate and prevent it." Based on what you all said about compassion [insert participant responses here], we can see how we have all experience this feeling of compassion before, including understanding that someone is suffering and wanting to help them.

Flows and blocks of compassion:

As we've been defining what compassion is, you've probably noticed that compassion can flow in many directions. We can be compassionate to others, we can receive compassion from others, and we can give compassion to ourselves. It is common for people to have blocks toward compassion for a wide variety of reasons.

For many, giving compassion to oneself is often the most difficult. You may be able to remember situations where you felt embarrassed about something you said or did, and asked yourself "Why would I do that? Why would I say that?" Sometimes we beat ourselves up rather than giving ourselves compassion.

5:00

Understanding our tricky brains

One of the reasons that it is difficult to give compassion to ourselves is because of the way our brains work. Have you ever been taught about what human brains are set up to do? Has anyone ever told you that our brains don't actually always work all that well?

(pause)

The way our brains work have been shaped by our experiences and life circumstances. Imagine if you had been born into a different family, different country, or in a different time period. Imagine how different you might be if you had different life experiences.

So how do our life experiences affect the way our brains work? Let's look at an example. Imagine you were hoping to get to know a person better and you knew they were attending a party you were attending. Let's say you get there and you wave at them from across the room,

but they don't react. Your initial reaction might be anxious—They must not like me!—when the reality may be that they were having a difficult day or were preoccupied with something else. Their actions may have nothing to do with you at all.

Perhaps you had this reaction because in the past you may have been rejected or bullied by others. Difficult experiences like this can leave their mark, and lead our brains to think the worst in future situations, even when the circumstances might be completely different. Our brains want to protect us from ever feeling rejected or bullied again, so they may have the tendency to interpret situations as threatening when they are not. This can cause us to stress out about many small interactions in our lives, and continue to ruminate about them, which can cause us more distress.

One of the first steps we can take toward being compassionate to ourselves is to recognize that we did not have any control over our life events. All of the suffering and difficulties we have had to face and the way they have affected how our brains process information—these are not our fault. This idea can be tricky to understand sometimes. Let's sit with it for a moment and see what comes up for us.

(pause)

Do folks have reactions or questions to what we've discussed so far?

(pause and wait for answers)

9:00
Using compassion to soothe ourselves
The exciting thing about compassion is that it is a skill that we can learn! We can help to change the way we react to situations to be more compassionate toward ourselves instead of ruminating or beating ourselves up. That is what we are going to practice next. First, we will be practicing compassion for a close friend or a loved one, and then for ourselves.

Compassion Practice (20 Minutes)

0:00
Settling:
We will now begin the compassion practice. Get comfortable in your chairs, feet flat on the floor, sitting upright, shoulders back, and chest open. If you're comfortable, gently close your eyes or just direct your gaze downwards.

Start to slow your breathing a little and settle into your mind and body.

(pause)

1:00

Soothing Rhythm Breathing
Now, let's focus on soothing rhythm breathing. I will count you into this. For those of you who find counting distracting, feel free to just work on slowing your breath to an even, slow, comfortable rhythm. For those of you for whom counting is helpful, here we go:

Breathing in 2…3…4…5 and out 2…3…4…5

In 2…3…4…5 and out 2…3…4…5

As you develop your rhythm, notice and focus on the feeling of inner slowing with each out breath. Gradually get that sense of grounding—a sense of stilling and slowing while maintaining an alert mind. Notice yourself becoming more grounded.

On each alternate out breath, say with a friendly supportive voice silently to yourself:

Body slowing down

Mind slowing down

Now we are going to tune into our inner compassion. We all just find ourselves here with a very tricky brain and certain life experiences that have shaped how our minds and bodies work, which have created the version of ourselves that we are. And we can learn how to change and make choices—develop compassion for ourselves and others.

1:30
Compassion for a close other:
Now, I invite you to think of someone you care about. Bring this person to your mind, as if they were standing here, right in front of you.

Notice how it feels to imagine this person in front of you… *(Pauses between each question)* Notice the sensations around your heart… Perhaps you feel a sensation of warmth, openness, and tenderness…

(10 second pause)

Continue breathing, and focus on these feelings as you visualize your friend or loved one. As you breathe out, imagine that you are sending them the following compassionate wishes from your heart, wishing them peace and happiness. At the same time, silently recite these phrases.

"May you be happy.
May you be free from suffering.
May you be healthy and strong.
May you be able to live in this world peacefully, joyfully, and with ease."

"May you be happy.
May you be free from suffering.

May you be healthy and strong.
May you be able to live in this world peacefully, joyfully, and with ease."

(30 second pause)

Continue to silently recite,
"May you be happy.
May you be free from suffering.
May you be healthy and strong.
May you be able to live in this world peacefully, joyfully, and with ease."

(30 second pause)

As you silently repeat these phrases, remember to send the compassionate wishes to your friend or loved one from your heart. Feel with all your heart that you wish your friend or loved one happiness and freedom from suffering.

(30 second pause)

Now think of a time when this person was suffering. Maybe they experienced an illness, an injury, or a difficult time in a relationship... *(15 seconds)* Notice how you feel when you think of his or her suffering…*(Pauses between each question)* How does your heart feel? … Do the sensations change?… Do you continue to feel warmth, openness and tenderness?… Are there other sensations, perhaps an aching sensation? *(10 seconds)* Continue to visualize your friend or loved one as you breathe. Imagine that you are extending the compassionate wishes from your heart to your friend or loved one, and that your compassion is easing their suffering. Extend compassion to them during your exhalation, with the strong heartfelt wish that they be free from their suffering. Recite silently to them:

"May you be free from this suffering…
May you have joy and happiness"

(30 second pause)

"May you be free from this suffering…
May you have joy and happiness"

(30 second pause)

"May you be free from this suffering…
May you have joy and happiness"

(1 minute pause)

Notice how this feels in your heart… *(Pauses between each question)* What happened to your heart? … Did the sensations change?… Did you continue to feel warmth, openness and

tenderness?… Were there other sensations, an aching sensation perhaps?... Did you have a wish to take away the other's suffering? *(Allow silence until next time point, at least 10 seconds)*

10:00

Compassion for self:

Now I want you to shift to contemplate a time when you have suffered yourself. Perhaps you experienced a conflict with someone you care about, or did not succeed in something you wanted, or were physically ill… *(15 seconds)* Notice how you feel when you think of your suffering…

How does your heart feel? … *(Pauses between each question)* Do you continue to feel warmth, openness and tenderness?… Are there other sensations, perhaps an aching sensation? *(10 seconds)*

Just as we wish for our friend or loved one's suffering to end, we wish that our own suffering would end. We may also envision our own pain and suffering leaving us so that we may experience happiness.

Continue to visualize yourself as you breathe. Imagine compassion emanating from your heart is easing your suffering. With each exhalation, feel the compassion emanating within you, with the strong heartfelt wish that you be free from your suffering. Silently recite to yourself:

"May I be free from this suffering…
May I have joy and happiness"
"May I be free from this suffering…
May I have joy and happiness"

(1 minute)

Continue to silently say to yourself,
"May I be free from this suffering…
May I have joy and happiness"

(1 minute)

"May I be free from this suffering…
May I have joy and happiness"

(1.5 minutes)

Again, notice how this feels in your heart… What kind of sensations did you feel? … *(Pauses between each question)* Did they change from when you were envisioning your own suffering?… How is this feeling different from when you wished your friend or loved one's suffering to be relieved?... Did you feel warmth, openness and tenderness?… Were there other sensations such as pressure? Did you have a wish to take away your own suffering?

(Allow silence until next time point, at least 10 seconds)

19:30
Closing:
Okay, now just start to let these thoughts and motivations go. Start to come back slowly into the room, noticing your bodies in the chair, feet on the ground, and when you are ready, you can open your eyes.

Question Session (5 Minutes)

What questions do you have about the activities we've done together today?

Fidelity Form for Compassion Intervention

Soothing Rhythm Breathing	**Yes**	**No**
Welcomes students and introduce instructor(s)		
Introduces soothing rhythm breathing		
Practices soothing rhythm breathing		
Discusses what to do when mind wanders (redirect to the breath)		
Didactic Instruction	**Yes**	**No**
Discusses how the practice taps into our "soothing system"		
Leads a brief imaginative exercise about helping someone who was struggling		
Defines compassion		
Discusses "flows of compassion" and the difficulty of giving compassion to oneself		
Discusses the way our brains are shaped by life experiences		
Discusses the first step to being self-compassionate is to realize we did not have control over life events that shaped us		
Introduces compassion practice by saying we will now try to cultivate compassion		
Compassion Practice	**Yes**	**No**
Starts practice with soothing rhythm breathing		
Asks participants to tune into how compassion feels in the body (e.g., warmth, tenderness, etc.)		
Practices compassion for a loved one		
Practices compassion for self		
Question Session	**Yes**	**No**
Asks “What questions do you have about the activities today?”		
Answers participant questions, if any (If there are no questions, mark "Yes")		

Appendix B

Active Control Intervention

Thoughts and Emotions Article (5 Minutes)

Students will have 3 minutes to read a short article on attention and 2 minutes to consider a list of questions about the article.

0:00
Thoughts and Emotions Article Reading:
What Happens to Your Body When You're Thinking? (from Verywell Mind)

3:00
Thoughts and Emotions Article Questions to Consider:

1. What are some key points to understanding how thoughts work?
2. How are thoughts and emotions (feelings) related?
3. Think about a time in which you found your thoughts affected your emotions (feelings).
4. In your own words, how would you define thinking after reading this article?

Didactic Instruction (10 Minutes)

0:00
Thinking and experience:
That was the first of several activities that we will be doing together today. We are going to take the next few minutes discussing the article we just read and how it relates to the next activity, in which we will be learning cognitive reappraisal. This article was all about learning about thinking, specifically how thoughts are considered in psychology. Thoughts can influence the way we experience the world.

Let's take an example that we've all probably had. Who has ever had the thought, "I need to get to school or get to class" and then after driving somewhere or walking to class, you realize that you've made it to your destination, without really remembering how you got there?

(pause to wait for responses)

This is an example of us being on "auto pilot." When we have a thought such as "I need to get to school," it can set a chain of events in motion that allow you to get somewhere, and sometimes we can get into a state where we are just 'going through the motions' without really paying attention to the world around us. The article we just read was how our thoughts are connected to our bodies in different ways. Next we are going to discuss how our thoughts are connected to our emotions or feelings.

3:00
Paying attention influences feeling:
Remembering different situations can influence how we feel. Let's try a little experiment to see how this works. Try to recall an experience from the past two years that was difficult or stressful for you and continues to upset you when you think about it. It could be a major event that upset you considerably or it could be a minor event that upset you recently Examples would include a stressful exam, a lower-than-expected grade, a disagreement with your roommate, a difficult conversation with a boyfriend or girlfriend, arguing with a parent, or troubling news from a family member.

(Pause while participants are remembering)

Does everyone have an experience in mind?

(Pause and wait for answers)

How did the situation make you feel?

(Pause and wait for answers)

How is the situation making you feel right now?

Notice how when we experience or remember difficult or stressful experiences, they can change how we feel – both in the moment, and later on when we think about them. What we remember change the way we feel and how we experience the world around us.

8:00
Thoughts and feelings:
The exercise you just did was about how stressful situations and memories of those situations can influence how we feel. This shows us that what we think about can influence how we feel.

This is an important part of understanding how thoughts and feelings are related. Often, when we are in a stressful situation, our thoughts can soothe us or exacerbate our feelings of stress. For the next activity, turn your attention to the worksheet in front of you. Now we would like you to try to think about the experience in a *different, less upsetting* way. I am going to help you to do this by providing some instructions.

Cognitive Reappraisal (20 Minutes)

Think of someone you know well, a specific person who has a much different personality than your own, and tends to react to things much differently than you do. Think of someone who would think in a way where he or she would react to the situation less negatively. It could be a family member, a friend, a romantic partner, or anyone else you know well. Please write the name of the person and your relationship to that person in

4.A. and B. {10 seconds}. How do you think that person would view the same experience if they went through it? {10 seconds}. Write some of the thoughts that person would be likely to have, that are different from your own, in the space provided. You have five minutes for this part of the reappraisal task. Please write for the entire time if possible.

5:00
You have one minute left for this part of the task. If you have finished writing, use the next minute to review the thoughts you attributed to the other person.

6:00
Now finish writing, if you haven't already. {5 seconds} Before moving to the next section of the worksheet, we would like you to make two ratings.
First, how reasonable does the other person's view of the experience seem to you? Use a scale from 0 to 100, where 0 means his or her view seems completely unreasonable and 100 means his or her view seems completely reasonable.

6:30
Second, how do you feel about the experience now after considering this point-of-view? Use a scale from 0 to 100, where 0 means you have no bad feeling at all and 100 means you have that feeling more intensely than ever before in your life.

7:00
We would again like you to try to think about the experience in a *different, less upsetting* way, and we are going to help you to do this by providing some instructions.
Imagine that instead of feeling upset in the situation, you had very little emotional reaction at all. {10 seconds}. How might you see the situation that would lead you to feel neutral about it? {10 seconds}. Write some of the thoughts you would have to think, in order to be unaffected by the experience, in the space provided. You have five minutes for this part of the reappraisal task. Please write for the entire time if possible.

11:30
You have one minute left for this part of the task. If you have finished writing, use the next minute to review the thoughts you would have to think in order to be unaffected by the experience.

12:30
Now finish writing, if you haven't already. {5 seconds} Before moving to the next section of the worksheet, we would like you to make two ratings.
First, how reasonable does this view of the experience seem to you? Use a scale from 0 to 100, where 0 means the view seems completely unreasonable and 100 means the view seems completely reasonable.

13:00
Second, how do you feel about the experience *now* after considering this point-of-view? Use a scale from 0 to 100, where 0 means you have no bad feeling at all and 100 means you have that feeling more intensely than ever before in your life.

13:30
Now finish writing, if you haven't already. {5 seconds} We would again like you to try to think about the experience in a *different, less upsetting* way, and we are going to help you to do this by providing some instructions.

Imagine your life a full year from now. Imagine that it has been a very good year. You have been enjoying yourself and accomplishing your goals. {10 seconds}. How might you look at the experience *differently*, a full year from now? {10 seconds}. Write some of the thoughts you might have about the experience, a year from now, in the space provided. You have five minutes for this part of the reappraisal task. Please write for the entire time if possible.

18:00
You have one minute left for this part of the task. If you have finished writing, use the next minute to review the thoughts you might have about the experience, a full year later.

19:00
Now finish writing, if you haven't already. {5 seconds} To complete the worksheet, we would like you to make two ratings.

First, how reasonable does this view of the experience seem to you? Use a scale from 0 to 100, where 0 means the view seems completely unreasonable and 100 means the view seems completely reasonable.

19:30
Second, how do you feel about the experience after considering this point-of-view? Use a scale from 0 to 100, where 0 means you have no bad feeling at all and 100 means you have that feeling more intensely than ever before in your life.

20:00
This concludes the task. Thank you for your attention.

Questions (5 Minutes)

What questions do you have related to the activities we completed today?

Fidelity Form for Active Control Intervention

Thinking Article	**Yes**	**No**
Welcomes students and introduce instructor(s)		
Introduces article on attention (What Happens to Your Body When You're Thinking?)		
Asks students to read article		
Provides questions to consider about the article		
Didactic Instruction	**Yes**	**No**
Discusses “autopilot” and give examples (e.g., driving and/or walking to class) and how our thoughts can influence our bodies		
Discusses that how our thoughts can influence how we feel		
Leads imaginative exercise about difficult or stressful experience		
Asks participants how the situation made them feel when it happened		
Asks participants how the situation is making them feel right now		
Discusses that what we think about can influence how we feel		
Introduces cognitive reappraisal activity by saying we are going to think about the experience in a “different, less upsetting” way		
Cognitive Reappraisal Practice	**Yes**	**No**
Asks participants to imagine and write about how another person (e.g., friend, family member) might react to the situation.		
Asks participants to try to imagine and write about themselves experiencing the situation in a different, less upsetting way		
Ask participants to imagine and write about their life a year from now		
Asks participants to rate how they feel about the experience after considering this new point of view		
Question Session	**Yes**	**No**
Asks “What questions do you have about the practice?”		
Answers participant questions, if any		

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Curriculum Vitae

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EDUCATION

2023	Ph.D., School Psychology, Syracuse University (*expected*)
2022 - 2023	Behavioral Health & Clinical Psychology Predoctoral Internship, Rochester Institute of Technology
2021	M.S., Psychology, Syracuse University
2014	B.S., Biomedical Engineering, Michigan Technological University Minor: Ethics & Philosophy

AWARDS AND HONORS

2022	Cornell FIRST Future Faculty Symposium Scholar
2021	Research Excellence Doctoral Funding Fellowship ($22,500)
2019 - 2021	Women in Science and Engineering Future Professionals Program Associate
2019	Mind and Life Institute New Investigator
2014	Departmental Scholar for Biomedical Engineering
2014	Honorable Mention, Michigan Technological University Engineering Design Expo
2010 - 2014	Dean's List
2010 - 2014	Presidential Excellence Scholarship
2010	Robert C. Byrd Honors Scholarship

CURRENT GRANTS

2021 - 2023	Lesbian Health Fund Grant GLMA: Health Professionals Advancing LGBTQ Equality Title: *Effects of self-compassion practice on stress reactivity among sexual minority women* Role: Principal Investigator Amount: $10,000

PAST GRANTS

2021 - 2022 Dr. Christine Blasey-Ford Grant
American Psychological Foundation
Title: *Experiences of self-compassion and compassion from others among sexual assault-exposed sexual minority women*
Role: Principal Investigator
Amount: $1,250

2020 - 2021 Small Research Grant
Syracuse University Intelligence Community Center for Academic Excellence
Title: *The influence of discriminatory experiences on career intentions among diverse military-connected students and servicemembers*
Role: Principal Investigator
Amount: $1,200

PEER-REVIEWED PUBLICATIONS

1. **Helminen, E. C.** & Scheer, J. R. (in press). Physiological, self-report, and behavioral stress reactivity to the group-based Trier Social Stress Test with pandemic-related protocol adaptations. *International Journal of Psychophysiology*. https://doi.org/10.1016/j.ijpsycho.2023.03.005

2. Scheer, J. R., Wall, M. M., Veldhuis, C. B., Ford, J. V., Cascalheira, C. J., **Helminen, E. C.**, Shaw, T. J., Jaipuriyar, V. Zaso, M. J., Hughes, T. L. (in press). Associations between latent classes of trauma exposure and minority stressors and substance use among sexual minority women. *Journal of Interpersonal Violence*.

3. Hier, B. O., MacKenzie, C. K., Ash, T. L., Maguire, S. C., Nelson, K. A., **Helminen, E. C.**, Watts, E. A., Matsuba, E. S. M., Masters, E. C. Finelli, C. C., Circe, J. J., Hitchings, T. J., Goldstein, A. R., & Sullivan, W. E. (in press). Effects of the Good Behavior Game on students' academic engagement in remote classrooms during the COVID-19 pandemic. *Journal of Positive Behavior Interventions*.

4. **Helminen, E. C.**, Scheer, J. R., Ash, T. L., Haik, A. K., & Felver, J. C. (2023). Discrimination, depression, and anxiety among sexual minority and heterosexual young adults: The role of self-compassion. *LGBT Health.* https://doi.org/10.1089/lgbt.2022.0079

5. Scheer, J. R., Cascalheira, C. J., **Helminen, E. C.**, Shaw, T. J., Schwarz, A. A., Jaipuriar, V., Brisbin, C. D., Batchelder, A. W., Sullivan, T. P. & Jackson, S. D. (2023). "I know myself again, which makes me motivated for life": Feasibility and acceptability of using experience sampling methods with trauma-exposed sexual minority women. *Journal of Interpersonal Violence*. 08862605231153888. https://doi.org/10.1177/08862605231153888

6. **Helminen, E. C.**, Ash, T. L., Cary, E. L., Sinegar, S. E., Janack, P., DiFlorio, R., & Felver, J. C. (2023). Gender differences in the stress-buffering effects of mindfulness facets on substance use among low-income adolescents. *Addictive Behaviors*, 136, 107491. https://doi.org/10.1016/j.addbeh.2022.107491

7. Ash, T. L., **Helminen, E. C.**, Yamashita, S., & Felver, J. C. (2023). Teachers' anti-Black biases in disciplinary decisions: The role of mindfulness. *Journal of School Psychology*, *96*, 75–87. https://doi.org/10.1016/j.jsp.2022.11.003

8. **Helminen, E. C.**, Ducar, D. M., Scheer, J. R., Parke, K. L., Morton, M. L., & Felver, J. C. (2022). Self-compassion, minority stress, and mental health in sexual and gender minority populations: A meta-analysis and systematic review. *Clinical Psychology: Science and Practice*. https://doi.org/10.1037/cps0000104

9. Felver, J. C., Cary E. L., **Helminen, E. C.**, Schutt, M. K., Gould, L. F., Greenberg, M., Roeser, R., Baelen, R. N., & Schussler, D. L. (2022). Identifying Core Program components of mindfulness-based programming for youth: Delphi approach consensus outcomes. *Mindfulness*. https://doi.org/10.1007/s12671-022-02015-1

10. Cascalheira, C. J., **Helminen, E. C.**, Shaw, T. J., & Scheer, J. R. (2022). Structural determinants of tailored behavioral health services for sexual and gender minorities in the United States, 2010 to 2020: A panel analysis. *BMC Public Health*, 22(1), 1908. https://doi.org/10.1186/s12889-022-14315-1

11. **Helminen, E. C.**, Cascalheira, C. J., Shaw, T. J., Zollweg, S., Hughes, T. L., & Scheer, J. R. (2022). A latent class analysis of tailored substance use treatment programs: Implications for treating syndemic conditions facing sexual and gender minority populations. *Drug and Alcohol Dependence*, 238, 109550. https://doi.org/10.1016/j.drugalcdep.2022.109550

12. Scheer, J. R., **Helminen, E. C.**, Felver, J. C., & Coolhart, D. (2022). Nonmedical social determinants, syndemic conditions, and suicidal thoughts and behaviors in a treatment-seeking community sample: A latent class analysis. *Archives of Suicide Research*. https://doi.org/10.1080/13811118.2022.2108741

13. **Helminen, E. C.**, Scheer, J. R., Edwards, K. M., & Felver, J. C. (2022). Adverse childhood experiences exacerbate the association between day-to-day discrimination and mental health symptomology in undergraduate students. *Journal of Affective Disorders*. *297*, 338–247. https://doi.org/10.1016/j.jad.2021.10.058

14. **Helminen, E. C.**, Zhang, X., Clawson, A. J., Morton, M. L., Cary, E. L., Sinegar, S. E., Janack, P., & Felver J. C. (2022). Stress-buffering effects of mindfulness programming for adolescents in schools during periods of high and low stress. *ECNU Review of Education*. https://doi.org/10.1177/20965311221100563

15. **Helminen, E. C.**, Scheer, J. R., Jackson, S. D., Brisbin, C. D., Batchelder, A. W., Cascalheira, C. J., & Sullivan, T. P. (2021). PTSD symptoms and hazardous drinking indicators among trauma-exposed sexual minority women during heightened societal stress. *Behavioral Medicine*. https://doi.org/10.1080/08964289.2021.2006132

16. Scheer, J. R., Edwards, K. M., **Helminen, E. C.**, & Watson, R. J. (2021). Victimization typologies among a large national sample of sexual and gender minority adolescents. *LGBT Health*, *8*(8). https://doi.org/10.1089/lgbt.2021.0024

17. **Helminen, E. C.**, Scheer, J. R., & Felver, J. C. (2021). Gender differences in the associations between mindfulness, self-compassion, and perceived stress reactivity. *Mindfulness, 12*(9), 2173–2183. https://doi.org/10.1007/s12671-021-01672-y

18. **Helminen, E. C.**, Morton, M. L., Wang, Q., & Felver, J. C. (2021). Stress reactivity to the Trier Social Stress Test in traditional and virtual environments: A meta-analytic comparison. *Psychosomatic Medicine. 83*(3), 200–211. https://doi.org/10.1097/PSY.0000000000000918

19. Zhang-James, Y., **Helminen, E. C.**, Franke, B., Hoogman, M., & Faraone, S. V. (2021). Evidence for similar structural brain anomalies in youth and adult attention-deficit/hyperactivity disorder: A machine learning analysis. *Translational Psychiatry, 11*(1), 1–9. https://doi.org/10.1038/s41398-021-01201-4

20. Becker, M., Bartalotta, A., Morton, M. L., **Helminen, E. C.**, Clawson, A. J., & Felver, J. C. (2020). The effects of mindfulness-based stress reduction in the higher education workplace: A pilot study. *Journal of Integrated Social Sciences, 10*(1), 136-154.

21. Morton, M. L., **Helminen, E. C.**, & Felver, J.C. (2020). A systematic review of mindfulness interventions on psychophysiological responses to acute stress. *Mindfulness*, *11*(9), 2039–2054. https://doi.org/10.1007/s12671-020-01386-7

22. Felver, J. C., **Helminen, E. C.**, & DiFlorio, R. (2020). Ultra-brief mindfulness intervention for highly stressed professionals: A pilot open trial. *Journal of Alternative and Complementary Medicine, 26*(3), 247–248. http://doi.org/10.1089/acm.2019.0311

23. **Helminen, E. C.**, Morton, M. L., Wang, Q., & Felver, J. C. (2019). A meta-analysis of cortisol reactivity to the Trier Social Stress Test in virtual environments. *Psychoneuroendocrinology*. *110*, 104437. https://doi.org/10.1016/j.psyneuen.2019.104437

24. Wang, Y., **Helminen, E. C.**, & Jiang, J. (2015). Building a virtual simulation platform for quasistatic breast ultrasound elastography using open-source software: A preliminary investigation. *Medical Physics*, *42*(9), 5453–5466. http://doi.org/10-.1118/1.4928707

PEER-REVIEWED BOOK REVIEW AND BOOK CHAPTER

1. **Helminen, E. C.** (2020). Book review of Christina Feldman and Willem Kuyken: Ancient wisdom meets modern psychology. *Mindfulness*. *11*(10), 2452-2453. http://doi.org/10.1007/s12671-020-01409-3

2. Felver, J. C., Clawson, A. J., **Helminen, E. C.**, Koelmel, E. L., Morton, M. L., & Sinegar, S. E. (2018). Reconceptualizing the measurement of mindfulness. In D. Grimes, H. Lin, & Q. Wang (Eds.), *Empirical Studies of Contemplative Practices* (pp.19-42). New York, NY: Nova Science Publishers.

MANUSCRIPTS UNDER REVIEW

1. **Helminen, E. C.**, Scheer, J. R., Coldon, A., & Felver, J. C. (revise and resubmit). Self-compassion is associated with self-reported stress reactivity and recovery to social-evaluative stress with gender variations. *Mindfulness*.

2. Scheer, J. R., **Helminen, E. C.**, Cascalheira, C. J., Jaipuriar, V., Shaw, T. J., Zabelski, S., Behari, K., Pirog, S., Batchelder, A. W., Possemato, K., Hughes, T. L. & Sullivan, T. P. (revise and resubmit). Probable PTSD, PTSD symptom severity, and comorbid PTSD and alcohol use disorder among sexual minority women compared to heterosexual women: A meta-analysis. *Clinical Psychology Review*.

3. Cary, E. L., Sinegar, S. E., Schutt, M. K., Bergen-Cico, D., **Helminen, E. C.**, & Felver, J. C. (revise and resubmit). Self-regulation mediates effects of Mindfulness-Based Stress Reduction on anxiety. *American Journal of College Health.*

4. Cascalheira, C. J., Nelson, J., Flinn, R. E., Zhao, Y., **Helminen, E. C.**, Scheer, J. R., Stone, A. L. (revise and resubmit) High-risk polysubstance use among LGBTQ+ people who use drugs in the United States: An application of syndemic theory. *International Journal of Drug Policy*.

PRESENTATIONS

1. **Helminen, E. C.** (2023, April). Trauma Exposure and Alcohol Use among Sexual Minority Couples. Paper presented at the 2023 RIT Graduate Showcase, Rochester Institute of Technology, Rochester, NY.

2. **Helminen, E. C.** (2022, October). Designing Compassion-Based Interventions to Address Sexual and Gender Minority Health Disparities. Presented at the Cornell FIRST Future Faculty Symposium, Cornell University, Ithaca, NY.

3. Scheer, J. R., Cascalheira, C. J., **Helminen, E. C.**, Shaw, T. J., Schwarz, A. A., Jaipuriar, V., Brisbin, C. D., Batchelder, A. W., Sullivan, T. P. & Jackson, S. D. (2022, October). "I know myself again, which makes me motivated for life": Feasibility and Acceptability of Using Experience Sampling Methods with Trauma-Exposed Sexual Minority Women. Poster presented at the 2022 Gender and Health: Impacts of Structural Sexism, Gender Norms, Relational Power Dynamics, and Gender Inequities Workshop, NIH Office of Research on Women's Health, virtual.

4. Scheer, J. R., Caceres, B. A., **Helminen, E. C.**, Cascalheira, C. J., Schwarz, A. A., Jaipuriyar, V., & Hughes, T. L. (2022, October). Psychosocial and Behavioral Correlates of Memory-Related Help-Seeking among Sexual Minority Women 50 Years of Age or Older. Poster presented at the 2022 Gender and Health: Impacts of Structural Sexism, Gender Norms, Relational Power Dynamics, and Gender Inequities Workshop, NIH Office of Research on Women's Health, virtual.

5. **Helminen, E. C.** & Felver, J. C. (2022, March). Advances in Mindfulness-Based Interventions for Adolescents: Expert Consensus for Core Components of Mindfulness-Based Programming. Symposium paper presented at the Society for Research on Adolescence (SRA) 2022 Biennial Meeting, New Orleans, LA.

6. Felver, J. C. & **Helminen, E. C.** (2022, February). Expert Consensus of Youth Mindfulness-Based Program Components and Instructor Competencies. Paper presented at the National Association for School Psychology (NASP) 2022 Annual Convention, Boston, MA.

7. Scheer, J. R., Edwards, K. M., **Helminen, E. C.**, & Watson, R. J. (2021, August). Victimization Typologies Among a Large National Sample of Sexual and Gender Minority Adolescents. Symposium paper presented at the 129th Annual Convention of the American Psychological Association, virtual.

8. **Helminen, E. C.** & Ducar, D. M. (2021, July). Self-Compassion, Minority Stress, and Mental Health in Sexual and Gender Minority Populations. Paper presented at the 32nd International Congress of Psychology, virtual.

9. **Helminen, E. C.** (2021, June). The Influence of Discriminatory Experiences on Career Intentions Among Diverse Military-Connected Students and Servicemembers. Paper presented at the Syracuse University Intelligence Community of Academic Excellence Mini Grant Symposium, virtual.

10. **Helminen, E. C.**, Ducar, D. M., Vigna, A. J., & Felver, J. C. (2020, November). The Potential of Self-Compassion to Promote Individual Flourishing in Sexual and Gender Minority Populations. Symposium presented at Mind and Life Contemplative Research Conference 2020, virtual.

11. Felver, J. C., Cary, E. L., **Helminen, E. C.**, Schutt, M. K. & Gould, L. (2020, November). Expert Consensus of Mindfulness-Based Programming Components, Practices, and Instructor Competencies: Results from a Delphi Study. Poster presented at Mind and Life Contemplative Research Conference 2020, virtual.

12. **Helminen, E. C.** (2020, July). The Potential of Self-Compassion for Sexual and Gender Minority Mental Health. Paper presented at Preach 2020: An International LGBTQ Psychology Online Conference, virtual.

13. **Helminen, E. C.**, Ducar, D. M., Parke, K. L., Morton, M. L., & Felver, J. C. (2020, June). The Importance of Self-Compassion in Sexual and Gender Minority Populations. Poster presented at Mind and Life Summer Research Institute 2020: Cultivating Prosocial Development Across the Lifespan, virtual.

14. **Helminen, E. C.**, Morton, M. L., and Felver, J. C. (2019, June). A Pilot Study of the Effects of Brief Daily Mindfulness Training on Stress and Well-Being in Principals. Poster presented at the 2019 Mind and Life Summer Research Institute, Garrison, NY.

15. Morton, M. L., **Helminen, E. C.**, and Felver, J. C. (2019, June). Learning to BREATHE (L2B) Buffers Adolescent Responses to Stress. Poster presented at the 2019 Mind and Life Summer Research Institute, Garrison, NY.

16. Felver, J. C, **Helminen, E. C.**, Morton, M. L., and Sinegar S. E. (2019, June), Reconceptualizing the Measurement of Mindfulness. Poster presented at the 2019 Mind and Life Summer Research Institute, Garrison, NY.

17. Morton, M. L., Zhang, X., Bennett, S., **Helminen, E. C.**, and Felver J. C. (2019, May). Effects of a Contemplative Intervention for Stress. Poster presented at the Department of Psychology 26th Annual Poster Session, Syracuse, NY.

18. **Helminen, E. C.**, Bennett, S., Zhang, X., Morton, M. L., and Felver, J. C. (2019, May). Effects of a Brief Mindfulness Program on Stress and Quality of Life for School Administrators. Poster presented at the Department of Psychology 26th Annual Poster Session, Syracuse, NY.

19. Becker, M., Bartalotta, A., **Helminen, E. C.**, Clawson, A. J., and Felver, J. C. (2018, May). The Effects of Mindfulness-Based Stress Reduction in the Workplace: A Pilot Study. Poster presented at the Department of Psychology 25th Annual Poster Session, Syracuse, NY.

20. Wang, Y., **Helminen, E. C.**, and Jiang, J. (2014, October). Building a Virtual Breast Elastography Phantom Lab Using Open-Source Software. Paper presented at the 2014 IEEE International Ultrasonics Symposium, Chicago, IL.

WORKSHOPS AND INVITED LECTURES

1. **Helminen, E. C.** (2022, November). Minority Stress and Resilience among Trans and Gender-Diverse People. Invited lecture presented in the Mental Health Needs of Transgender and Nonbinary People graduate course at Columbia University, New York, NY.

2. **Helminen, E. C.** & Felver, J. C. (2021, October). Experiences of LGBTQ+ Students in Schools. Professional development workshop presented to the Syracuse University School Psychology Doctoral Program, Syracuse, NY.

3. **Helminen, E. C.** (2021, April). How to Publish as a Graduate Student. Invited lecture presented in the Behavior Therapy Practicum graduate course at Syracuse University, Syracuse, NY.

4. **Helminen, E. C.** (2020, April). Providing Spaces for Queer Military-Connected Students on Campus. Seminar presented at the Barnes Center at the Arch – Counseling, Syracuse University, Syracuse, NY.

5. **Helminen, E. C.** (2020, April). Compassion-Focused Therapy for College Student Populations. Seminar presented at the Barnes Center at the Arch – Counseling, Syracuse University, Syracuse, NY.

6. **Helminen, E. C.** (2020, April). Understanding Self-Compassion: Benefits and Misconceptions. Invited lecture presented in the Mindfulness: Science and Practice course at Syracuse University, Syracuse, NY.

RESEARCH EXPERIENCE

2020 - Graduate Research Assistant
Minority Stress and Trauma Lab
Department of Psychology, Syracuse University
Supervisor: Dr. Jillian Scheer, Assistant Professor and Licensed Psychologist

2017 - 2022 Graduate Research Assistant
Mind Body Lab
Department of Psychology, Syracuse University
Supervisor: Dr. Joshua Felver, Assistant Professor and Licensed Psychologist

2020 - 2021 Graduate Research Intern
Concussion Clinic
Department of Rehabilitation Psychology, Upstate Medical University
Supervisor: Dr. Brian Rieger, Clinic Director and Licensed Psychologist

2017 - 2018 Post-Bac Research Assistant
ADHD and Machine Learning Research
Department of Psychiatry, Upstate Medical University, Syracuse, NY
Supervisor: Dr. Yanli Zhang-James, Associate Professor

2013 - 2014 Undergraduate Research Assistant
Virtual Modeling Research
Department of Biomedical Engineering, Michigan Technological University
Supervisor: Dr. Jingfeng Jiang, Assistant Professor

2013 - 2014 Senior Design Project Team Member
Leadless Pacemaker Project
Department of Biomedical Engineering, Michigan Technological University
Supervisor: Dr. Rupak Rajachar, Assistant Professor

2012 Process Engineer Intern
Medical Device Research and Development
SurModics, Inc., Eden Prairie, MN
Supervisor: Tim Kloke, Senior Manager

TEACHING EXPERIENCE

2022 Guest Lecturer
Mental Health Needs of Transgender and Nonbinary People (graduate)
School of Nursing, Columbia University

2021 Guest Lecturer
Behavior Therapy Practicum (graduate)
Department of Psychology, Syracuse University

2021 Guest Lecturer
Mindfulness: Science and Practice (undergraduate)
Department of Psychology, Syracuse University

2019 Guest Lecturer
Developmental Psychopathology (graduate)
Department of Psychology, Syracuse University

2018 - 2019 Recitation Instructor
Foundations of Human Behavior (undergraduate)
Department of Psychology, Syracuse University

2013 - 2014 Undergraduate Teaching Assistant

Mechanics of Materials (undergraduate)
Department of Mechanical Engineering and Engineering Mechanics, Michigan Technological University

EDITORIAL APPOINTMENT

2020 - Editorial Board Member
Mindfulness

AD HOC JOURNAL REVIEWER

International Journal of School & Educational Psychology
Journal of Adolescent Health
Journal of School Psychology
Neuroscience and Biobehavioral Reviews
Psychology in the Schools
Race and Social Problems
Scientific Reports

PROGRAM SERVICE

2020 - 2022 Student Liaison to Faculty
2020 - 2022 Peer Mentor
2019 - 2021 Communications Committee Member
2019 - 2020 Diversity, Equity, and Inclusion Committee Member
2019 - 2020 NASP Student Affiliate
2019 - 2020 NYASP Student Affiliate

DEPARTMENT SERVICE

2022 Psychology Research Initiative in Diversity Enhancement (PRIDE) Research Mentor
2019 - 2022 Psychology Action Committee Member
2020 - 2021 Psychology Action Committee Program Representative

UNIVERSITY SERVICE

2018 - 2022 Student Veteran Liaison
2020 Transgender Health and Wellness Team Member
2019 Disability Community Group Member

NATIONAL SERVICE

2022 - Transhealth Research Advisory Board Member
2021 - 2022 Department of the Air Force LGBTQ+ Initiative Team Civilian Member

TRAININGS AND CERTIFICATIONS

2022 Critical Incident Stress Management Certification
2022 Motivational Interviewing Workshop
2021 Managing Bias Training
2020 APA Best Practices in Telehealth Training
2019 Compassion-Focused Therapy (CFT) and Compassionate Mind Training (CMT) Training Retreat
2019 Soles of the Feet Teacher Training
2018 Trauma Focused Cognitive Behavioral Therapy (TF-CBT) Certification
2018 Learning to BREATHE (L2B) Teacher Training
2018 Mindfulness Training for Teachers
2018 Military Cultural Competency Training
2018 Compassion Cultivation Training (CCT)

PROFESSIONAL AFFILIATIONS

2022 - American Psychological Association (APA)
2019 - APA Division 44 – Sexual Orientation and Gender Diversity
2019 - 2021 APA Division 16 – School Psychology
2020 - 2021 APA Division 19 – Society for Military Psychology
2022 National Association for School Psychology
2019 - National Center for Faculty Development & Diversity

CLINICAL EXPERIENCE

2022 - 2023 Predoctoral Clinical Intern
Priority Behavioral Health Clinic, Rochester Institute of Technology

Supervisor: Dr. Cory Crane, Licensed Psychologist

2021 - 2022 School Psychology Practicum
Institute of Technology at Syracuse Central High School
Practicum Supervisor: Dr. Joshua Felver, ABPP, Licensed Psychologist
Site Supervisor: Dr. Althea Henry, Licensed Psychologist

2020 - 2021 Neuropsychological Assessment Intern
Center for Children's Cancer and Blood Disorders, Upstate Medical University
Supervisor: Dr. Brian Rieger, Licensed Psychologist

2021 Behavior Therapy Practicum
Syracuse City School District
Supervisor: Dr. Bridget Hier, BCBA

2019 - 2020 Mental Health Counseling Intern
Barnes Center at the Arch – Counseling, Syracuse University
Supervisor: Dr. Carrie Brown, Licensed Psychologist

2020 Systems Consultation Practicum
Soule Road Elementary School, Liverpool, NY
Site Supervisor: Kimberly Loughlin, School Psychologist
Practicum Supervisor: Dr. Bridget Hier, BCBA

2018 - 2019 Group Therapist for Test Anxiety
Syracuse University
Supervisor: Dr. Joshua Felver, ABPP, Licensed Psychologist

2018 - 2019 Individual and Group Mindfulness Interventionist
Syracuse City School District, Syracuse, NY
Supervisor: Dr. Joshua Felver, ABPP, Licensed Psychologist

PROFESSIONAL EXPERIENCE

2014 - 2017 Technical Writer
Software Development, Schneider Electric (now AVEVA)
Supervisor: Kristen Cogburn, Head of Technical Communications

2015 - 2017 Freelance Nonprofit Consultant