

DISPOSITIONAL MINDFULNESS AND SELF-COMPASSION AND THEIR INFLUENCE
ON OXYTOCIN AND PARASYMPATHETIC FUNCTIONING

BY

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Abstract

This study examined the relations between dispositional levels of trait mindfulness and self-compassion and two physiological stress markers during a lab stress task: Oxytocin (OT) and respiratory sinus arrhythmia (RSA) (an indicator of parasympathetic nervous system functioning). Although there is some literature to suggest that induced state mindfulness alters physiological functioning, there is a paucity of research examining trait levels in association with physiological outcomes. Trait levels may be important to well-being given the practice of being more mindful and self-compassionate is not merely an exercise, but lifestyle characteristics of being aware of and accepting of the present moment. Furthermore, while self-compassion and mindfulness are clinically discussed and taught together, they are rarely studied together empirically to determine their relative impacts on wellness outcomes. To fill these gaps, data were collected from 68 college-age students, who after completing one of two stress studies in the lab, were contacted to complete measures for trait mindfulness and self-compassion. Linear regressions, controlling for appropriate controls, found that trait self-compassion was significantly associated with less OT during stress. Additionally, trait mindfulness was marginally related to OT during recovery from stress. In particular, those high in trait mindfulness had a steeper decline in OT levels after stress. Effects remained the same for self-compassion even when conceptually related personality traits were controlled for, but mindfulness was no longer marginally related to OT recovery when neuroticism was controlled for. No significant results were found for RSA. Results suggest that self-compassion may be more beneficial during stress while mindfulness may be most effective during recovery. Implications regarding the relationship between mindfulness and self-compassion and future research directions are discussed.

Dispositional Mindfulness and Self-Compassion and their influence on Oxytocin and Parasympathetic Functioning

In the last decade there has been a dramatic growth of interest in mindfulness meditation (Baer, 2003) and its relationship to health. This work has primarily been done assessing clinical interventions that examine how altering the experience of mindfulness and related constructs (e.g., compassion for the self and others) can influence health. These interventions have been shown to alter a number of health related outcomes including disease symptoms and healthy vaccination responses, among others (Baer, 2003; Carlson, Speca, Patel, & Goodey, 2003; Costa & Pinto-Gouveia, 2011; Davidson & Harrington, 2002; Davidson, et al., 2003; Williams, Kolar, Reger, & Pearson, 2001; Wren, et al., 2012). This research has generally ignored the possibility that naturally occurring mindfulness and self-compassion (e.g., at a dispositional level) may also have health benefits. It is important to study trait levels of these constructs so that we can pinpoint how naturally occurring mindfulness and self-compassion influence the body. Understanding these associations will clarify when their use may be more advantageous. Although, there is growing evidence that mindfulness and self-compassion influence physiological outcomes in this trait area of research (Brown, Ryan, & Creswell, 2007; Creswell, Way, Eisenberger, Lieberman, 2007; Rockliff, Gilbert, McEwan, Lightman, & Glover, 2008; Vest Rogers, 2009), this work is still in its infancy and there are many remaining questions. Critically, is the issue of *how* exactly these constructs influence health. Without understanding the mechanisms underlying benefits of these variables, it is unclear when individuals with these traits will be helped and relatedly, under what conditions these types of interventions might also be helpful. The goal of the current study is therefore to better understand the influences of trait mindfulness and self-compassion on physiological outcomes that might underlie the benefits of these measures on health outcomes.

Understanding the constructs: Mindfulness and Self-Compassion

Before moving forward into understanding the physiological pathways that might underlie the benefits of mindfulness and self-compassion, it is important to fully understand what these constructs measure and their similarity and differences. **Trait mindfulness** is defined as the general tendency to direct attention on the experiences occurring in the present moment in a nonjudgmental and accepting way, without attempts to change or avoid them in everyday life (Baer, 2003; Germer, Siegel, & Fulton, 2005). Trait mindfulness has been supported as a construct related to decreased rumination (Coffey & Hartman, 2008), the tendency to engage in negative, repetitive, frequently self-focused thought about the future or past, and is therefore thought of as an adaptive form of self-reflection. **Trait self-compassion**, on the other hand, is defined as the tendency to be open and moved by one's own suffering, experiencing feelings of caring and kindness toward oneself without judgment or self-blame, and recognizing that one's experience is part of the common human experience (Neff, 2003b).

Mindfulness, in an intervention format, is increasingly being taught in conjunction with self-compassion given that self-compassion is a deeper form of acceptance and awareness of turning towards all thoughts, emotions, and sensations (Germer & Salzberg, 2009). Whereas mindfulness teaches acceptance to what's happening to us—accepting feelings, thoughts, and emotions, self-compassion is acceptance of the person to whom it's happening. Self-compassion is acceptance of oneself while in pain (Germer, 2009). Both mindfulness and self-compassion work by encouraging individuals to develop a new relationship with emotional distress, and Neff (2003b) suggests a reciprocal relationship in which they facilitate and enhance each other. However, self-compassion is thought to be a skill that helps individuals recognize that they need kindness and care in particular distressing situations when regulating attention and the breath is

too challenging (Germer, 2009). Furthermore, self-compassion “may reduce the perceived severity or threat of negative thoughts and feelings, making it easier to maintain mindful awareness of them” (Baer, Lykins, & Peters, 2012, p. 231). Although mindfulness and self-compassion overlap, distinctions exist. Mindfulness is broadly applied to neutral, unpleasant, and pleasant events, whereas self-compassion is more narrowly focused on suffering (Germer & Salzberg, 2009). Overall, research suggests that trait mindfulness and self-compassion are unique predictors of psychological functioning and happiness (Hollis-Walker & Colosimo, 2011). In this study, Hollis-Walker & Colosimo (2011) reported that trait self-compassion partially mediated the mindfulness-psychological well-being relationship, and they concluded that this is supporting evidence that mindfulness cultivates a compassionate attitude which in turn prevents the effects of negative feelings and facilitates well-being. In addition, a greater proportion of variance was explained when trait mindfulness and self-compassion were both considered in predicting psychological well-being.

While frequently *taught* together clinically, and while the two conceptually overlap, as traits they are rarely studied together. Given their distinct characteristics and the desire of many clinicians and practitioners to teach them together, it is of critical importance to understand the relative contributions and interactions between mindfulness and self-compassion. Some researchers have conceptualized self-compassion as an attitude that aids in the cultivation of mindfulness (Brown, Ryan, & Creswell, 2007), while others include the key elements of self-compassion in their definition of mindfulness (Marlatt & Kristeller, 1999), and mindfulness is also commonly included in the definition of self-compassion (Neff, 2003a; 2003b). This creates a challenge in that the concepts overlap with one another. There are two scales of Neff’s self-compassion scales (2003b) that directly measure mindfulness and the opposite of Neff’s

conceptualization of mindfulness, over-identification. From a measurement perspective, this makes it difficult to tease apart the unique effects of the constructs. Others report evidence that the levels of self-compassion increase as a product of increased mindfulness (Bishop, et al., 2004; Brown, et al., 2007). This illustrates some confusion in the literature over exactly how these variables are interrelated. On top of this work, past findings have also indicated that trait self-compassion predicts adaptive psychological functioning (e.g., symptom severity and quality of life) over and above trait mindfulness (Van Dam, Sheppard, Forsyth, & Earleywine, 2011). This might suggest that these individual variables, while related, have some distinct role in improving wellness.

Given the above very limited actual evidence that self-compassion is theoretically distinct from mindfulness and that it may be driving the therapeutic changes associated with mindfulness practices, it makes sense to explore the benefits of self-compassion above and beyond a dispositional mindfulness outlook. Specifically, mindfulness in combination with self-compassion may result in synergistic improvements to well-being. This path, however, has yet to be investigated. The question therefore remains—what is the role of self-compassion in mindfulness research?

How do trait mindfulness and self-compassion influence health?

There is a growing amount of research connecting trait mindfulness to markers of health function, for example Vest Rogers (2009) has shown that those high in trait mindfulness experience greater high frequency heart rate variability (HF HRV), an indicator of parasympathetic functioning, compared to those low in trait mindfulness during relaxation and across the span of one evening at the participant's home (Vest Rogers, 2009). Higher scores on trait mindfulness have also predicted greater satisfaction in self-reported physical health and

number of visits made to medical professionals over the past 21 days (Bränström, Duncan, & Moskowitz, 2011; Brown & Ryan, 2003; Roberts & Danoff-Burg, 2010). In a longitudinal study, Murphy, Mermelstein, Edwards, & Gidycz (2012), examined the relationship between dispositional mindfulness, health behaviors (e.g. sleep, eating, and exercise), and physical health in college women at the beginning and end of a 10-week academic quarter. Higher trait mindfulness was related to healthier eating, better sleep quality, and better physical health (even when controlling for traditional health habits). Higher levels of trait mindfulness have also been inversely related to somatization, or the tendency to experience distress in terms of physical complaints, in both college and community adult samples (Brown & Ryan, 2003). In line with research suggesting that mindfulness promotes superior somatic awareness and functioning, O'Loughlin & Zuckerman (2008) found that individuals high in trait mindfulness show a stronger correlation among physiological activity (measured by levels of salivary dehydroepiandrosterone (DHEA), a steroid indicator of physical health and immune functioning) and reported physical symptom awareness. Their findings suggests that individuals high in mindfulness, compared to those low in mindfulness, are not only less likely to have physical symptoms but when they do, they are more accurate at identifying their physical symptoms (O'Loughlin & Zuckerman, 2008). Similarly, components of trait mindfulness, acting with awareness and non-judgment, in combination with increased body awareness were found to be associated with lower premenstrual symptom severity (Gerrish, 2011). Trait mindfulness is rarely studied in unhealthy populations, but one recent study (Salmoirago-Blotcher, Crawford, Carmody, Rosenthal, & Ockene, 2011) found that in a sample of 30 outpatients with implantable cardioverter defibrillators who were naïve to mindfulness training, higher trait mindfulness was observed in patients who exercised at least once a week compared to patients who did not.

Overall, these studies suggest that individuals higher in trait mindfulness report fewer physical illness symptoms, evidence greater parasympathetic and immune functioning (indicated by related health indicators), and are more aware of their physical functioning. There is currently more research measuring global health, such as self-reported physical functioning, compared to specific physiological pathways and health markers (e.g. blood pressure, markers of sympathetic and parasympathetic functioning, and immune parameters) leaving the mechanisms underlying these benefits unclear.

Additionally, there is substantially more research measuring health markers before and after clinical trials involving mindfulness training. While studying traits may not seem fruitful from the clinical perspective given how difficult it is to change traits, mindfulness can change upon exposure and training (Baer et al., 2008; Carmody & Baer, 2008). Carmody and Baer (2008) found that time spent engaging in home practice of formal meditation exercises was significantly related to the extent of improvements in mindfulness levels, and increases in mindfulness were found to mediate the relationships between practice and improvements in psychological functioning, health symptoms, and well-being. Researchers are just now beginning to report the interactive relationship between practice time effects during clinical trials, trait mindfulness, and health indicators (Vettese, Toneatto, Stea, Nguyen, & Wang, 2009) and future work is warranted to explore these associations more thoroughly.

While changes in the stress process are possibly the most likely path connecting these factors to health, there are in fact only two studies (Brown, Weinstein, & Creswell, 2012; Vest Rogers, 2009) that have specifically examined trait levels of mindfulness and its stress-buffering role under controlled laboratory conditions. Higher trait mindfulness predicted lower cortisol responses to a social evaluative stress challenge, relative to a control task, as well as lower

anxiety and negative affect. These associations remained significant when controlling for the role of other variables (e.g. fear of negative evaluation) that predicted cortisol and affective responses (Brown, Weinstein, & Creswell, 2012). Vest Rogers (2009) did not find any effects on trait mindfulness in relation to HF HRV during a sad film clip known to elicit negative emotion. However, the authors noted that this finding ran counter to Arch and Craske's (2006) study showing that controlled breathing resulted in greater HF HRV during an emotionally intense film clip.

Alterations in stress reactivity and recovery as a plausible pathway connecting Mindfulness and Self-Compassion to Health

There is far less work connecting self-compassion with health-related outcomes (Rockliff, et al., 2008, 2011) and currently there is no existing research relating *trait* levels of self-compassion with health indicators making it unclear whether being dispositionally more compassionate towards the self is in fact better for physical wellness. Surprisingly, while mindfulness and self-compassion have both been discussed theoretically as powerful psychological mechanisms capable of influencing the physiological response to stress (Terry & Leary, 2011; Wang, 2005a), there are currently no studies that have examined both constructs simultaneously in the context of stress or stress recovery.

As mentioned above, one possible pathway by which these variables may influence health is via their influence on the body's physiological response to stress. Physiological stress reactivity, when tested in the lab, consists of an initial rest, or baseline period, followed by a period during which the participant is exposed to a stressor (for example, an arithmetic challenge). Accompanying physiological measurements record the consequent stress-related change, which is called reactivity (Linden, Earle, Gerin, & Christenfeld, 1997). Recovery may be

defined as a post-stress rest period that documents information about the degree to which the stress response in the physiological marker being measured persists after the stressor has ended (Linden, et al., 1997). Reactivity and recovery are important physiological responses that have both been shown to have health prognostic capabilities (Jennings, et al., 2004; Matthews, Salomon, Brady, & Allen, 2003). For example, they were found to be good predictors of future hypertension and related cardiovascular disease outcomes (Matthews, et al., 2004). Trait mindfulness *and* self-compassion associations with stress and recovery have not been examined.

Why might mindfulness and self-compassion be specifically relevant to the processes of stress reactivity and recovery, despite their relative neglect in this field to date? Mindfulness theoretically prevents individuals from replaying the events of a stressor and may be specifically seen as a strategy to improve psychological recovery after a stressful event. Mindfulness may also act as a tool to help individuals respond in the present moment to a given stressor in that it allows practitioners to act more reflectively rather than impulsively (Bishop, et al., 2004; Kabat-Zinn, 1994). Therefore, it is clear theoretically how mindfulness may influence an individual during stress and during recovery from a stressful event.

Trait self-compassion has been found to help buffer against anxiety when faced with an ego-threat stressor in laboratory settings (Neff, Kirkpatrick, & Rude, 2007) and is therefore thought to alter stress appraisal. Given that reduced threat perception is known to be tied to stress reactivity and recovery (Hellhammer & Schubert, 2012; Oldehinkel, et al., 2011; Waugh, Panage, Mendes, & Gotlib, 2010), self-compassion should influence the physiological stress response. Furthermore, related to the question addressed above regarding differential effects of these traits, it is plausible that one may be more influential in regard to the processes involved during a stressful situation, while the other is a more effective recovery tool. However,

researchers have not examined the relative influence of these variables in regard to the time points surrounding a stressful event.

What health relevant physiological measures are connected to self-compassion and mindfulness during stress?

There are several different physiological markers that can document reactivity and recovery responses given that stress involves the activity of multiple integrated neural and neuroendocrine systems. The branch of the autonomic nervous system of greatest interest in the current work is the parasympathetic nervous system (PNS), the division of the nervous system responsible for rest and relaxation. For example, it has been shown to have an important role in decreasing heart rate and becoming more active during periods of safety, stability, and recovery from stress (Porges, 1995). Greater PNS input results in more pronounced acceleration and deceleration of respiration and more variable intervals between beats, also known as higher heart rate variability (HRV) (Berntson, Cacioppo, & Quigley, 1993; Somsen, Jennings, & Van Der Molen, 2004), a variable known to have important correlations with health outcomes.

HRV is commonly reported as an index of PNS functioning. HRV, or the variance between the heartbeats, may be expressed as a function of frequency. This allows one to separate out the relative influences of the sympathetic and parasympathetic nervous system on the heart rate due to their differing temporal dynamics (Task Force, 1996). The high frequency band (.15-.40 Hz) is an index of PNS activity, while the low frequency band (.04-.15 Hz) reflects a more complex interplay of autonomic influence (Berntson, et al., 1997; Cohen, Matar, Kaplan, & Kotler, 1999; Eckberg, 1997). Another way to report heart rate frequencies is by capturing patterns in respiration (also known as respiratory sinus arrhythmia, or RSA). The heart speeds up during inspiration and slows down after expiration. More parasympathetic input results in a more

pronounced RSA. RSA and HF HRV are therefore two widely acceptable markers of parasympathetic functioning (Berntson, et al., 1997; Cacioppo, et al., 1995).

Regarding their health relevance, lower levels of HF HRV have been shown to predict sudden death, cardiovascular disease risk, mortality risk, as well as other morbidity outcomes (Algra, Tijssen, Roelandt, Pool, & Lubsen, 1993; Bigger, et al., 1992; Dekker, et al., 2000; Liao, et al., 1997; Tsuji, et al., 1994). Psychologically, past research results suggest that higher HRV reflects a greater capacity for emotional regulation and the use of constructive coping (Appelhans & Luecken, 2006; Fabes & Eisenberg, 1997; Geisler & Kubiak, 2009).

It is possible that individuals who are high in trait mindfulness and self-compassion have better stress responses due to higher PNS activity during stress, operationalized as smaller changes in cardiovascular activity during stress (e.g., smaller decreases in high frequency heart rate variability (HF HRV) or faster returns to resting levels of HRV following the end of a stressor). This benefit will likely occur given research findings that during mindfulness meditation practice, individuals have higher levels of HF HRV (Ditto, Eclache, & Goldman, 2006; Takahashi, et al., 2005).

Trait mindfulness and self-compassion however, clearly differ from active and in the moment meditation practice. Individuals high in trait levels of mindfulness and/or self-compassion may or may not have this benefit when facing stressful events. It may be more realistic to observe how a participant physiologically and psychologically responds to a stressor given their trait way of responding rather than priming a participant to “cope mindfully and self-compassionately”—provided we do not have an option to decide how to cope with an unknown stressor before it arrives. In addition, being more mindful and self-compassionate is not merely an exercise, but lifestyle characteristics of being aware of and accepting of the present moment.

Similarly, trait responses may give researchers a better sense of how mindfulness and self-compassion naturally alter the stress response.

Past research has related trait and state levels of mindfulness to resting HF HRV (Ditto, et al., 2006; Takahashi, et al., 2005; Vest Rogers, 2009) and self-compassion induction (Rockliff, et al., 2008). For example, trait levels of mindfulness have been associated with higher HF HRV in comparison to those low in trait mindfulness during relaxation and throughout the day and was not related to average higher HRV throughout an emotion-evoking film clip (Vest Rogers, 2009) yet researchers have not focused on specific changes in HF HRV during reactivity and recovery after the film clip. Trait levels of self-compassion have not been explored in relationship to HF HRV; however, one study explored HF HRV during a self-compassion induction. Two different patterns emerged from this study—one group showed an increase in HF HRV following self-compassion induction whereas the other showed a decrease in HF HRV (Rockliff, et al., 2008). The group with higher mean scores of self-criticism, self-coldness, and anxious attachment style responded with a decrease in HF HRV, suggestive that they viewed the compassion-based imagery as a threatening activity. However, the group with higher means scores of trait self-compassion, self-reassurance, and the ability to depend on others showed an increase in HF HRV (Rockliff et al., 2008). This suggests that trait qualities may also influence an individual's ability to experience self-compassionate states of mind, and in turn levels of parasympathetic functioning.

Another physiological mechanism thought to play a role in stress reactivity is the neuropeptide and hormone Oxytocin (OT). OT is known to be important for the stress response in that at a broad level, OT has been associated with regulation of the hypothalamic–pituitary–adrenal (HPA) axis—a major neuroendocrine stress response system that serves to adapt the

organism to changing conditions and thereby helps in maintaining stability and health (McEwen, 2004; Uvnas-Moberg, Bjokstrand, Hillegaard, & Ahlenius, 1999). Specifically, higher OT has been tied to lower blood pressure (Grewen & Light, 2011), lower levels of the stress hormone cortisol (Cardoso, Ellenbogen, Orlando, Bacon, & Jooper, 2012; Taylor et al., 2006), and has been found to be associated with increased PNS activity (Dreifuss, Dubois-Dauphin, Widmer, & Raggenbass, 1992; Gamer & Büchel, 2012; Grippo, Trahanas, Zimmerman, Porges, & Carter, 2009; Uvnas-Moberg, 1997). Recently, intranasal administration of OT was found to produce significant increases in HF HRV (Norman et al., 2011). Furthermore, a review on the OT literature has elucidated that naturally occurring as well as administered OT decrease anxiety and improves the stress response, possibly, because of the pro-social and affiliative tendencies triggered by OT during stress (Taylor et al., 2000). Researchers have also found that OT in combination with positive social interactions attenuates the stress response (Taylor et al., 2006). This might lead one to draw the conclusion that higher levels of OT are inherently beneficial if they attenuate the stress response either directly or indirectly due to their influence on social behaviors (DeVries, Glasper, & Detillion, 2003; Kikusui, Winslow, & Mori, 2006).

Despite these studies, there is also evidence to support a contradictory hypothesis. For example, high levels of circulating OT have been related to increased levels of distress, such as interpersonal discord and threats to the attachment system (Taylor et al., 2006; Taylor, Saphire-Bernstein, & Seeman, 2010; Turner, Altemus, Enos, Cooper, & McGuinness, 1999). To explain this contradiction, Taylor (2006) deduced that oxytocin—in addition to its function in supporting social behavior during non-stressful circumstances—might also be part of an evolved biobehavioral system whose role is to motivate individuals to seek out social support during times of stress. Since Taylor's (2006) hypothesis regarding the meaning of increased OT,

experimental studies have examined OT in the context of lab stress tasks. Some researchers have documented increased levels of OT that correlate with perceived stress during challenging lab tasks (Pierrehumbert et al., 2010). However, stress-induced OT elevations have not been observed in several studies and the literature at this point is continuing to develop (Altemus et al., 2001; Heinrichs et al., 2001; Taylor et al., 2006). While it is currently unclear how to explain what high levels of circulating OT mean, Taylor's model (Taylor et al., 2006) explains how the context matters and when OT is produced under stressful circumstances it may be interpreted as an indicator of distress.

To date, OT has not been tied to trait mindfulness or self-compassion. Furthermore, some researchers have theoretically suggested that OT is not a major contributor to non-social stimuli (Ferguson, Young, & Insel, 2002). However, given that the relationship one has with oneself may be one of the most important social relationships in life, self-compassion then arises as a plausible social stimulus capable of interacting with OT. Furthermore, it is important to highlight that OT is produced under familiar social situations as opposed to unfamiliar. Similarly, we may find that since mindfulness and self-compassion encourage openness, non-judgment, and kindness towards thoughts and feelings (Wang, 2005), this familiarity and comfort with oneself (again, potentially thought of as a relationship), these constructs may be capable of influencing OT. To illustrate this point further, consider the connection between thinking about directing compassion and love towards someone else and then transferring these feelings to oneself. The act of interacting with someone else in a compassionate way may result in the same physiological and psychological effects when directed to oneself.

The only evidence thus far to identify a relationship between OT and the variables of interest was a study designed to explore the effects of OT on Compassion Focused Imagery

(CFI; Rockliff et al., 2011). CFI is a technique used in which the participant imagines another “mind” being deeply compassionate to oneself and receiving feelings of warmth, understanding, and kindness. This tool has been shown to be an effective way of increasing feelings of self-compassion and self-reassurance in a number of mental health settings (Gilbert & Procter, 2006; Laithwaite, et al., 2009). In this study, participants completed self-report measures of self-criticism, attachment styles, and social safeness and attended two imagery sessions, one in which they received intranasal OT and a placebo in the other. Positive affect before and after each session and a rating of the imagery experience was gathered after each session. The researchers found that overall OT increased the ease of imagining compassionate qualities, but for participants higher in self-criticism, low in self-reassurance, social safeness and attachment security, they had less positive experiences of CFI under OT compared to placebo. This study was the first to examine OT and self-compassion together and suggests that trait factors (e.g. attachment, self-reassurance) influence individuals’ experience of OT. Overall, this study suggests that the relationship between OT, self-compassion, and related trait factors needs to be better understood (Rockliff et al., 2011).

The Current Study

The goals of this thesis are therefore to explore the nature of the relationships between the independent variables trait mindfulness, self-compassion, and the dependent variables OT and RSA during stress and recovery in response to a stressful task. It will specifically test whether trait mindfulness and self-compassion are uniquely correlated with RSA and OT as well as whether their effects are independent of one another, or whether they interact to produce synergistic effects. Before these tests are conducted, the relationship between mindfulness and self-compassion will be reported as evidence of their independence. In addition, there are two

components of the self-compassion scale used in the current study that measure mindfulness—over-identification and mindfulness. Therefore, given the infrequent study of the combination of mindfulness and self-compassion and the overlap between the two constructs, the correlations between mindfulness and self-compassion will be reported.

An important subset of analyses not previously discussed relates to the issue of constructs closely related to mindfulness and self-compassion. For example, given that previous research has discovered relationships between OT and attachment styles (Marazziti et al., 2006), it might be the case that attachment, a factor known to be associated with an individual's ability to behave and think self-compassionately (Rockliff et al., 2011), is what is actually responsible for any found benefits of the IVs of interest to this work. In addition, while trait mindfulness (Baer, Smith, Hopkins, Krietemeyer, & Toney, 2006) and self-compassion (Neff, 2003a) have been shown to be unique in comparison to common personality traits (e.g. agreeableness, conscientiousness, neuroticism, self-esteem), it is less commonly reported whether or not these constructs independently influence various dependent variables. Given the known correlations between some of these personality traits and stress responses (Borghini, Halfon, 2012; Garcia-Banda, et al., 2011; Pierrehumbert, Torrisi, Ansermet, Borghini, & Halfon, 2012; Suls, 2001; Walsh, Wilding, & Eysenck, 1994), it is also important to ensure that found effects of mindfulness and self-compassion are not simply due to well studied personality constructs known to be related to health outcomes (Friedman, 2000, 2008; Ozer & Benet-Martinez, 2006).

Below are the specific main hypotheses that will be tested in this study.

Hypothesis 1 states that both levels of trait mindfulness and self-compassion will independently be associated with better physiological responses to stress and recovery assessed by RSA and salivary OT. More adaptive physiological responses in regard to RSA will be

defined as higher mean values as compared to baseline. Given there is no existing research exploring OT and trait mindfulness and self-compassion during stress, analyses examining the relationship between reactivity and recovery will be exploratory in nature and there will not be any specific hypotheses regarding directionality of outcomes.

Hypothesis 2 predicts that self-compassion and mindfulness will have at least some unique explanatory power in predicting both RSA and salivary OT during stress and recovery given their conceptual uniqueness and their plausible differential associations with components of the stress response.

Hypothesis 3 predicts that there will be an interaction between trait mindfulness and self-compassion where individuals high on both will show greater benefit as compared to being high on only one variable, given that they are unique, separate constructs that may interact synergistically and has been proposed previously that both together is optimal (Hollis-Walker & Colosimo, 2011; Salzberg, 1997)

This work adds to the literature in several ways. First, by exploring a novel physiological pathway to better understand the trait level effects of mindfulness and self-compassion. Specifically, OT has not been examined in terms of its relationship to these independent variables and trait levels of self-compassion have never been tested in relationship to physiological functioning. Trait mindfulness has only been tested twice before in relationship to physiological functioning (Brown, Weinstein, & Creswell, 2012; Vest Rogers, 2009), and researchers did not examine the relationship between trait mindfulness during reactivity and recovery of a stress task. Next, no study has examined the interactive effects of mindfulness and self-compassion nor examined whether trait self-compassion and mindfulness are associated with physiological stress outcomes. This work will help us determine to what extent these variables

are important beyond existing, related constructs (e.g., personality types) that have also been related to similar physiological and health outcomes. Finally, more thoroughly investigating the role of mindfulness and self-compassion in the stress pathway and whether mindfulness and self-compassion have a particularly important role in undoing the physiological stress response (i.e., improving recovery via enhanced PNS activity) may inform clinicians in how they instruct clients to use mindfulness and self-compassion in the context of stress. Knowledge concerning how trait levels of mindfulness and self-compassion influence physiological functioning will provide a foundational ground whereby future studies can explore whether individual trait differences impact physiological functioning after mindfulness-based interventions.

Method

Participants

Participants were 68 individuals (53% female, 46% male) recruited if they had previously participated in a laboratory stress studies that assessed salivary OT (40 from Study 1 and 28 from Study 2). Eligible individuals were called and emailed to encourage participation in exchange for \$10.00. Participants were each contacted a maximum of three times prior to stopping recruitment efforts. The mean age of the participants was 20.92 years, with a range from 18-29 years. Ethnic backgrounds consisted of 71% Caucasian, 3% African-American, 17% Asian, 7% Hispanic, and 2% identifying as multi- or biracial. Other relevant physiological descriptive information includes the following: 42.5% women reported currently taking oral contraceptives; 7% of the sample smokes cigarettes on a daily basis; 11% of the sample reported taking over-the-counter allergy medication. The average BMI was 23.68 (SD = 5.99), with a range of 15.62-49.00.

Only fluent English speakers were eligible for participation, individuals without psychological disorders (e.g., Major Depressive Disorder, Generalized Anxiety Disorder, etc.),

and those without confounding medical conditions—including asthma, autoimmune diseases (i.e. hepatitis, rheumatoid arthritis, HIV), chronic sinusitis, bronchitis, cardiovascular disease, and any other chronic illnesses that might influence their physiological responses during the study. Pregnant and breastfeeding women were excluded given the known alterations in OT in this sample.

Materials

Demographics. Basic information such as age, race, gender, and education was collected.

Psychological Variables

Self-Compassion. Self Compassion Scale (SCS; Neff, 2003b) is a 26-item scale that measures the three distinct but closely related components of self-compassion—self-kindness versus self-judgment, common humanity versus isolation, and mindfulness versus over-identification. Participants are asked to indicate how often they behave for each item using a 5-point likert scale ranging from *almost never* to *almost always*. There are 5 items each from *self-kindness* (e.g. “I try to be understanding and patient towards those aspects of my personality I don’t like”) and *self-judgment* (e.g., “When I see aspects of myself that I don’t like, I get down on myself”) with respective alphas in the current sample of .84 and .73. *Common humanity* (e.g., “I try to see my failings as part of the human condition”) and *isolation* (e.g., “When I fail at something that’s important to me, I tend to feel alone in my failure”) have 4 items each and respective alphas of .60 and .73. *Mindfulness* (e.g., “When something upsets me I try to keep my emotions in balance”) and *over-identification* (e.g., “When something painful happens I tend to blow the incident out of proportion”) also have 4 items each and alphas of .73 and .70, respectively. In a large sample of students (Neff, 2003a), each subscale had adequate to good

internal consistency, the overall scale was not correlated with a measure of social desirability, and there was good test-retest reliability over three weeks (Neff, 2003a). (See Appendix 1 for full scale)

Mindfulness. The Five Facet Mindfulness Questionnaire (FFMQ; Baer, Smith, Hopkins, Krietemeyer, & Toney, 2006; Baer et. al., 2008) is a 39-item measure of the general tendency to be mindful in daily life. This measure was derived from an exploratory factor analysis of several previously developed mindfulness questionnaires (Baer, et al., 2006). The five facets include observing, describing, acting with awareness, non-judging of inner experience, and non-reactivity of inner experience. *Observing* includes noticing or attending to internal and external experiences, such as sensations, cognitions, emotions, sights, sounds, and smell ($\alpha = .82$). *Describing* involves labeling internal experiences with words ($\alpha = .85$). *Acting with awareness* is attending to one's activities of the moment and can be contrasted with behaving mechanically or automatically while attention is focused elsewhere (often called automatic pilot) ($\alpha = .79$). *Non-judging* of inner experience is taking a non-evaluative stance towards feelings and thoughts ($\alpha = .86$). *Non-reactivity* of inner experience is the tendency to allow thoughts and feelings to come and go, without getting carried away by or caught up in them ($\alpha = .82$). Each facet includes 8 items, except for the non-reactivity scale, which includes 7. Items are rated on a 5-point Likert scale ranging from 1 (never or very rarely true) to 5 (very often or always true). The five facets have been shown to be internally consistent and correlated in expected directions with numerous other constructs in several samples. They are also significantly correlated with the original mindfulness instruments from which they were derived. Regression, mediation, and confirmatory factor analyses have supported the validity and factor structure of the FFMQ, as well as the

utility of measuring the facets separately (Baer, et al., 2006; 2008). (See Appendix 1 for full scale)

Personality Variables. Ten Item Personality Inventory (TIPI), which assesses the Big Five personality traits with only ten items rated on a 7-point likert scale (Gosling, Rentfrow, & Swann, 2003; Much, Hell, & Gosling, 2007) was used. Levels of openness, conscientiousness, extraversion, agreeableness, and neuroticism were calculated. This measure has adequate validity and reliability, even though it is only ten items (Gosling, et al., 2003; Much, et al., 2007). This measure was collected during baseline of both studies.

Attachment Style. State Adult Attachment Measure (SAAM; Gillath, Hart, Nofhle, & Stockdale, 2009). This measure is designed to assess state-like variation in working models of attachment—including secure (e.g. I feel like others care about me), anxious (I really need to feel loved right now), and avoidant (If someone tried to get close to me, I would try to keep my distance). Research results suggest high levels of reliability and factors analyses have supported that validity and structure of the scales. The baseline attachment style questionnaire was used given that this measure was collected more than once, and collection times post baseline were not consistent across both studies.

Physiological and Health Variables

Oxytocin. Salivary samples were collected by collecting participants' drool into a 17x100mm polystyrene capped test tube to about 3/4th full. This takes approximately 2-4 minutes with the assistance of sugar-free gum to increase salivation, and has been shown to be an acceptable collection method in our laboratory. Samples were frozen at -20C immediately after collection and remained frozen until analysis. Salivary oxytocin levels were measured by the Assay Designs' Oxytocin Enzyme Immunoassay (EIA) kit (Catalog No. 900-153; 96 Well Kit).

This kit is a competitive immunoassay for the quantitative determination of Oxytocin in the samples and has been piloted by laboratory investigators in a study investigating the role of oxytocin in the stress response process. The kit uses polyclonal antibody to OT to bind, in a competitive manner, the OT in the sample or an alkaline phosphate molecule, which has OT covalently attached to it. Before the competitive assay, the salivary OT must be extracted from the saliva. The result of the extraction procedure ensures that sample concentrations within the assay are above the assay sensitivity level and are detectable on the linear portion of the standard curve. The first step included centrifuging the sample with a mixture of 0.1 trifluoroacetic acid in water (TFA-H₂O) at 17,000 for 15 minutes at 4°C to clarify and save the supernatant. Next, the 200 mg C Sep-Pak column was equilibrated with 1 mL of acetonitrile, followed by 10-25 mL of 0.1% TFA in water. Then, the supernatant was applied to the Sep-Pak column and washed with 10-20 mL of 0.1% TFA in water and then was discarded. The sample was then eluted by applying 3 mL of acetonitrile: 0.1% TFA in water 60:40. The remainder was collected in a plastic tube. Finally, the sample was eluted slowly and evaporated to dryness using a centrifugal concentrator under vacuum. Samples were stored at -20 °C. During the next phase, substrate is added. After a short incubation time the enzyme reaction is stopped and the yellow color generated read on a microplate reader at 405nm. The intensity of the bound yellow color is inversely proportional to the concentration of Oxytocin in either standards or samples. The measured optical density of the standards is used to calculate the concentration of Oxytocin in the sample. The hormone content (in pg/ml) was determined by plotting the OD of each sample against a standard dilution curve. Assay Designs -reactivity for similar mammalian neuropeptides in sera at less than 0.001.

Cardiovascular Recording. Heart rate was measured continuously throughout the study using electrocardiography (ECG). Using a MindWare BioNex ECG amplifier, ECG (and cardiovascular impedance data not reported in the current project) was obtained from nine electrodes placed on the upper and lower sternum, the right clavicle, left lower ribcage, and right lower ribcage (ground lead) on the anterior side of the body, and on the cervical and thoracic regions on the posterior side of the body. Data acquisition and recording of ECG was carried out using a MindWare BioLab 2.4 acquisition system, with a sampling frequency of 1000 Hz and a 60 Hz notch filter to reduce noise in the data. To derive RSA, the raw ECG data were first inspected using automated software and then visually inspected according to the guidelines for detecting artifacts and abnormal beats (Berntson, Quigley, Jang, & Boysen, 1990). HRV Analysis Software 6.1 (Mindware Cardiography system, Gahanna, OH) was used to verify, edit, and summarize cardiovascular data. For each participant, ECG data were ensemble averaged for each minute. The same HRV analysis software was used to derive heart rate variability (ms^2/Hz) by applying spectral analysis to the interbeat interval series (IBI series—the time between successive R-peaks) from the ECG. The IBI series was time sampled at (4 Hz) to produce an equal time series. The equal series was then de-trended, end tapered, and submitted to a fast Fourier Transformation according to procedures outlined by (Berntson et al., 1997). Spectral analysis was used to decompose heart rate variability at specific frequency components. RSA was computed by summing power spectral density values over the frequency band associated with respiration (0.15–0.50 Hz).

Health and Health Behavior Information (collected at the time of their participation in the stress study). A screening and health information form was completed to ensure that the participant was eligible for the study based on the absence of various health conditions (see

Appendix 1), pregnancy and breastfeeding status. In order to gather information on sleep, a modified version of the Pittsburgh Sleep Quality Index (PSQI; Buysse, Reynolds, Monk, Berman, & Kupfer, 1989) was used. Sleep duration, time in bed spent sleeping, sleep quality, and napping behavior over the past month were collected. Information related to smoking, alcohol and illicit drug use, and general level of physical activity was also collected as part of the baseline questionnaire packet (18 questions), as these have been associated with cardiovascular reactivity in previous literature (Goyal, Shimbo, Mostofsky, & Gerin, 2008). Additionally, experimenters measured participants' height and weight. These were used as possible control variables for the cardiovascular measurements given their known associations with health and heart outcomes. Additional information regarding current medications, especially the presence of birth control use and allergy medication was gathered, given that these variables have been associated with levels of OT (Aps & Martens, 2005)

Design and Procedure

To test study hypotheses, participants from two past studies on OT and cardiovascular stress were recruited and asked to complete measures of trait mindfulness and self-compassion as well as various other measures that assess important potential covariates as mentioned previously via an online questionnaire (N = 190 from original two studies). Both studies used a variant of the Trier Social Stress Test (TSST; Kirschbaum, Pirke, & Hellhammer, 1993). The TSST is a standardized experimental protocol that allows for the induction of moderate psychological stress in a laboratory setting while recording physiological responses to the stressor (Kirschbaum, Pirke, & Hellhammer, 1993). The protocol consists of an anticipation period (2 minutes) and a test period (3 minutes) in which the participants must deliver a speech in front of an evaluator (or evaluators in some studies) on a given topic and is instructed that they must maintain eye contact

and talk during the entire time period. Participants were also videotaped and told that their speech would be rated later for quality to enhance perceived stress perceptions. Following the speech, participants were allowed to recover from the stress quietly while cardiovascular measures were continuously recorded. Saliva samples for OT occurred at different times for the two stress studies. For one of the studies, OT was measured one minute into baseline, 15 minutes post speech task, and 10 minutes after the last stress task given there were two stress tasks present. In the other study, in which 28 of our participants were collected from, OT was measured 13 minutes into baseline, 13 minutes post speech, and 20 minutes after the post speech sample.

Statistical Approach

In order to test the relationship between mindfulness and self-compassion and their influence on RSA and OT, regression analyses were conducted. Before regressions were ran, the RSA data was averaged across each of baseline, stress, and recovery periods. Baseline RSA was defined as the average during the 10-minute baseline quiet resting period; stress reactivity was defined as average levels of RSA during the 5-minute socially evaluated preparation and speech after subtracting baseline levels of RSA (Egizio et al., 2008 Sheu, Matthews, & Gianaros, 2008; Matthews et al., 2003). Smaller change scores from baseline to stress is indicative of healthier responses to stress in that they are closer to resting levels of baseline functioning (less of a strong stress response). Recovery was defined as average levels of RSA during the stress task minus the average levels during the 6 minutes following recovery, controlling for baseline levels of RSA. Change scores are commonly used so that the values reflect changes from one portion of the study to the next and it allows for an easier comparison between participants, and baseline measures of the physiological measure are controlled for (Egizio, et al., 2008 Sheu, Matthews,

Gianaros, 2008; Linden, et al., 1997; Matthews, et al., 2003). RSA averages per each segment were analyzed to assure they approximated the normal distribution (skewness and kurtosis), and outlier data points were removed ($N = 20$) before the averages were calculated if they were two standard deviations above or below the mean in a case wise deletion and were not included in subsequent analyses.

OT measures included in analyses consist of one measure taken during baseline, one either 13 or 15 minutes post speech task, and one at the last minute of recovery of the entire study. The OT measure used for recovery was not taken immediately after the stress task (Kubzansky, Mendes, Appleton, Block, & Adler, 2009) and instead the OT sample during the last minute of recovery for both studies was used (for one study this was 25 minutes post speech and for the study in which 28 participants were used it was 33 minutes post speech). For statistical analyses, raw OT concentrations were square root transformed (Light, Grewena, & Amicob, 2005) to better approximate normal distributions. Baseline levels of OT were subtracted from the stress time-point so that results reflect change in OT concentration. Similar to cardiovascular measures, stress levels of OT were subtracted from recovery levels, and baseline OT was controlled for. Outliers were removed ($N = 8$) if they were two standard deviations above or below the mean in a case wise deletion and were not included in subsequent analyses.

Finally, before regressions were conducted, univariate analysis of variance and bivariate correlations were calculated to determine which demographic and theoretically related health behavior variables to control for based on group differences (between the two lab stress studies) and associations with the dependent variables of interest (HF HRV and OT). The variables entered into the correlation matrix with HF HRV and OT included the following: age, sex, race, BMI, allergy medication use, alcohol use, exercise, smoking, and sleep. Given that the current

study examined two different stress studies, a univariate analysis of variance (ANOVA) test was conducted to compare means of relevant outcome variables to test similarity of groups across studies. Additionally, in one of the stress studies, OT was administered intranasally. Also, both studies included priming conditions, so an ANOVA test examined any differences in relevant outcomes based on study priming and drug conditions.

Regression analyses (first testing for main effects and then per block) were used to test the current hypotheses controlling for variables associated with dependent variables of interest. Per the sub-hypotheses related to similar personality constructs, analyses were also conducted after controlling for relevant personality and attachment variables. Regressions will be reported both with and without controlling for related psychological constructs. For hypothesis 1, separate regression analyses were conducted predicting the dependent variables of interest (stress RSA, recovery RSA, stress OT, and recovery OT) for each of the independent variables of interest (self-compassion and mindfulness).

For hypothesis 2, in order to test for unique explanatory power and independent effects of mindfulness and self-compassion on relevant dependent variables, regressions were completed in which significant covariates were entered in the first block, mindfulness was entered in block 2, then self-compassion was entered in block 3, and the change in variance was observed by comparing the ΔR^2 values. The same procedure was completed in which significant covariates were entered in the first step, self-compassion was entered in block 2, then mindfulness was entered in block 3, and the change in variance was observed by comparing the ΔR^2 values.

In order to test hypothesis 3, total mindfulness and self-compassion scores were mean centered and then multiplied by one another to create an interaction term. Then, a regression was

ran in which significant covariates were controlled for in block 1, mindfulness and self-compassion were entered in block 2, and then the interaction was entered in block 3.

Results

Initial Analyses

Univariate ANOVA tests confirmed that there were no significant differences between the two different stress studies for baseline OT, $F(2,58) = 0.43, p > 0.05$; stress OT, $F(2, 58) = 0.58, p > 0.05$; recovery OT $F(2, 58) = 0.17, p > 0.05$; baseline RSA $F(2, 46) = 1.14, p > 0.05$; stress RSA $F(2, 46) = 0.50, p > 0.05$; or recovery RSA $F(2, 46) = .31, p > 0.05$. There were also no significant differences based on priming conditions for stress OT $F(2,58) = 0.27, p > 0.05$, Recovery OT $F(2,58) = 0.44, p > 0.05$; stress RSA $F(2,46) = 0.20, p > 0.05$; or recovery RSA $F(2,46) = 0.08, p > 0.05$. Intranasal OT administration was related to higher levels of post stress speech OT and recovery OT ($F(2,58) = 11.32, p < 0.05$ and $F(2,58) = 13.24, p < 0.05$ respectively). However, OT was not related to baseline, speech, or recovery RSA values ($p > 0.05$). Use of allergy medication was associated with levels of OT for all time points, and was thus controlled for in all OT analyses. Other significant correlations found that were controlled for in the appropriate subsequent analyses include the following: self-compassion and neuroticism ($r = -.26, p = .04$), mindfulness and openness ($r = .28, p = .02$), recovery levels of OT and secure attachment ($r = .35, p = .01$), and recovery HF HRV and conscientiousness ($r = -.32, p = .03$). No other demographic or health behaviors were related to dependent variables of interest. Refer to table 1 to see the correlations between mindfulness and self-compassion facets and total scores. Mindfulness and self-compassion were not strongly correlated ($r = .31, p < .01$). In addition, it is important to highlight that the mindfulness components of the self-compassion

scale—mindfulness and its opposite, over-identification, were not strongly correlated with the five facet mindfulness questionnaire, $r = .30$ ($p < .05$) and $r = -.34$ ($p < .01$), respectively.

Hypothesis 1 As seen in Table 2 and depicted in Figure 1, in a two-step regression, self-compassion did predict stress change score of OT (controlling for allergy medication and intranasal OT administration). Those with higher levels of self-compassion experienced a decrease in OT during the stress task while those lower in self-compassion showed an increase in OT during stress. Based on ΔR^2 scores, self-compassion accounted for 5% of the variance in stress levels of OT. As seen in Table 3, when neuroticism was controlled, self-compassion still significantly predicted stress change in OT and accounted for 5% of the variance in stress OT. Mindfulness was not related to OT levels during stress ($p > 0.05$, refer to Table 2), but was marginally related to recovery levels of OT ($p = 0.07$, see Table 2) and accounted for 6% of the variance in recovery levels of OT. Specifically, those with higher levels of trait mindfulness experienced a greater decline in OT levels after the stress task (see Figure 2). As seen in Table 4, when openness and secure attachment style were entered in block 1, mindfulness was still marginally significant in relation to recovery OT ($p = 0.08$). In addition, neuroticism (Table 3) emerged as a significant predictor of increased recovery OT levels ($p = 0.03$). Self-compassion was not related to recovery OT change scores (controlling for baseline OT) ($p > 0.05$).

There were no significant results for the independent effects of mindfulness, on stress or recovery change scores of RSA ($ps > 0.05$). When self-compassion was entered predicting stress change scores of RSA and recovery RSA change scores (controlling for baseline RSA), there were similarly no significant associations ($ps > 0.05$). The same null associations were found when controlling for related personality and attachment variables.

Hypothesis 2 Given that mindfulness was not related to stress changes in OT, the only regression ran with stress OT as the dependent variable tested for the unique effects of self-compassion over and above mindfulness. As indicated in Table 5, self-compassion still accounted for 4% of the explained variance ($ps < 0.05$) in predicting stress OT even when controlling for allergy medication, openness, neuroticism, secure attachment style, and critically, mindfulness. Likewise, self-compassion was not related to recovery changes in OT, so the only regression ran with recovery OT as the dependent variable tested for the unique effects of mindfulness over and above self-compassion. As indicated in Table 6, mindfulness was no longer a significant predictor of recovery OT after controlling for self-compassion and neuroticism ($p > 0.05$). When self-compassion was added in the second step, there was no change in the R^2 value.

Hypothesis 3 When significant covariates were entered, followed by mindfulness and self-compassion (with variables centered for the purpose of the interaction calculation), and then the mindfulness/self-compassion interaction term was entered in the last block, there were no significant effects for the interaction term ($ps > 0.05$) in predicting changes in stress RSA, recovery RSA, stress OT, or recovery OT. Interactions were also conducted looking at all of the covariates interacting with both self-compassion and mindfulness, and none were significant ($p > 0.05$) in predicting changes in stress RSA, recovery RSA, stress OT, or recovery OT.

Discussion

This study tested the associations between trait self-compassion and mindfulness with changes in OT and RSA during stress and recovery from a stress task. This was the first study to examine the effects of these two trait variables in relation to the stress response and the first to assess OT. Results indicated that individuals who are higher in trait self-compassion experience a

decrease in OT levels during the lab stress task irrespective of levels of mindfulness, which was not tied to stress OT. Decreases in OT during stress may be indicative that individuals high in self-compassion experienced the stress task as less physiologically challenging and/or threatening. Unfortunately these self-report mechanisms were not tested during the study.

Trait mindfulness was marginally related to lower recovery levels of OT (i.e., faster return towards baseline resting levels of OT). This suggests that trait mindfulness is more important during the recovery period of a stress task in comparison to trait self-compassion, albeit, in a somewhat small way given the non-significance of the finding and the lack of marginal effects once self-compassion and neuroticism were controlled ($p > .1$). When self-compassion was added in the second block, there was no observed change in R^2 (see Table 5). This suggests that the addition of neuroticism is what contributed to the change in significance. However, given that this study was conducted with a small sample and power was not estimated since no one has looked at OT and mindfulness and self-compassion before, future studies should investigate this topic further. This is the first study to find effects of trait neuroticism on OT, and this suggests that researchers should continue to control for related psychological factors.

Unfortunately, due to the infancy of the current OT literature, it is not currently clear what high levels of OT during a stress lab task means to well-being given that some stress studies have found corresponding increases in stress plasma OT and perceived stress during a challenging lab task (Pierrehumbert, et al., 2010) while others found no significant changes in plasma OT throughout a stress task (Taylor et al., 2006). In order to better understand how OT and self-compassion influence the stress response and whether these effects are healthy, future

research should examine the associations of self-compassion and OT, with other important physiological outcomes (e.g., blood pressure, heart rate, cardiac output).

In summary, given that self-compassion and mindfulness had associations with OT during different time points, this is suggestive that trait self-compassion plays a more significant role in OT during stress while trait mindfulness may play a greater role during recovery, although the latter interpretation should be tempered given the marginal effects. Interestingly, when examining the trajectories, those higher in trait mindfulness experienced an elevation in OT during stress and a steep decline during recovery (Figure 2). However, those high in trait self-compassion experienced a slight decrease in OT during stress and did not have much of a change in OT throughout all time points (Figure 1). This suggests that these two variables may not be closely tied to one another in terms of how they interact with OT given the highly different (and opposing) patterns.

The peak in OT during stress relating to high mindfulness parallels theoretical accounts that mindfulness encourages being aware of whatever is occurring in the mind each moment, and therefore mindfulness encourages individuals to notice their emotions quite vividly (Siegel, 2010, p.48). This could be harmful during stress because a person might be more in the moment and might pay greater attention to the associated feelings. However, during recovery, once the stressor is no longer present, mindfulness encourages awareness of the present instead of ruminating over the past stressor or worrying about the future (e.g., how one will be evaluated on stress task performance) and hence is consistent with the found decreases in OT during recovery. Steep stress recovery in cardiovascular outcomes (although never shown in OT) is typically thought to be beneficial to health, and as previously reported, has been linked to future healthy heart outcomes. On the flip side, self-compassion is thought to encourage acceptance particularly

during stressful situations (Germer & Salzberg, 2009, p.33) and plays a role in reducing perceived threats, and the OT stress results are consistent with this theoretical account.

Why was there no association between mindfulness, self-compassion and heart rate variability measures? Previous work on clinical interventions of mindfulness, has shown ties to cardiovascular outcomes where mindfulness is associated with healthier HRV (Ditto, 2006; Takahashi 2005). However, in the one study that did examine trait mindfulness during a lab stress task in relation to HF HRV (Vest Rogers, 2009), there were null effects. In a different study (Brown, Weinstein, & Creswell, 2012) that explored trait mindfulness during a stress task and found significant effects, the only physiological dependent variable reported was cortisol. This indicates one of two possible interpretations. First, trait levels of mindfulness and self-compassion may not be as strong of correlate of RSA as compared to when mindfulness is purposefully induced in the lab which likely results in higher state mindfulness at the moment of analysis (Ditto et al., 2006). It is also possible, that while PNS was hypothesized to be an important pathway by which mindfulness and self-compassion function that perhaps, this is not the case and that these factors operate on other components of the autonomic system during stress. In addition, because mindfulness involves acute awareness of the present moment, those high in mindfulness may have been more willing to focus on the stressful experience resulting in similar RSA values as those low in mindfulness. However, given ambulatory measures of RSA were not measured in this study, it is impossible to test whether resting levels of RSA throughout the day are dramatically different from levels during the stress task. There are also some design limitations of this work (discussed below), which may be partially responsible.

Why was there no interaction between self-compassion and mindfulness? Given the current findings that the two variables interact with OT in highly different (and opposing) patterns, these

two variables may not be closely related in regards to OT. However, self-compassion and mindfulness may interact with one another when different physiological pathways are inspected, and so future research should continue to investigate the interaction between self-compassion and mindfulness. In the current study, mindfulness was not as strongly correlated with self-compassion ($r = .34$), in comparison to reported correlations of ($r = .69$). Therefore, it would be interesting to examine the current hypotheses in a population in which the correlation between trait self-compassion and mindfulness is higher. Perhaps, the interaction would emerge in such a population. In addition, future research should determine if the two variables interact in a different context, such as during an emotionally salient stress task.

Finally, despite the conceptual overlap between mindfulness, self-compassion and some related personality variables, analyses testing whether these variables were related to our dependent variables of interest as well as those controlling for these related constructs did not find them to wipe out the found effects of mindfulness and self-compassion on components of the OT response. However, since neuroticism was significantly associated with recovery OT, future studies should continue to control for related personality traits.

To address the conceptual overlap between mindfulness and self-compassion, a post-hoc analysis examined hypothesis 1 using the self-compassion total score not including the facets of mindfulness and over-identification (see Table 7). (Recall that the self-compassion scale includes two facets to measure mindfulness—over-identification and mindfulness) Self-compassion was no longer a significant predictor of stress OT and the p-value was marginal, $p = .09$. This finding suggests that mindfulness is a critical component of self-compassion. This is preliminary support that in order for self-compassion to be the most beneficial, at least physiologically, it helps to be more mindful and have a balanced perspective free of over-reactivity.

Limitations

One weakness of the current study is that trait mindfulness and self-compassion were collected at a different time point in comparison to when the participant completed the stress-study. Some individuals completed the measures within a few weeks of the stress study, while others were contacted up to six months after stress-study completion. The difference in time points may influence the levels of reported self-compassion and mindfulness, given no one has tested the stability of scores on the SCS or the FFMQ for a length of time greater than a three-week period (Baer, Smith, & Allen, 2004; Neff, 2003a). Also, the two stress studies from which the data were drawn were not designed to test the current hypotheses, and so many of the factors that had to be taken into consideration (e.g. priming, intranasal OT administration) created potential confounds in the results that had to be statistically controlled for. While every attempt to account for these differences was taken, it is possible that there were other underlying differences not considered that might have altered the findings in some way. Also, several outliers existed in the current data set for RSA reduced the power to detect differences in these analyses. Finally, our method of assessing OT is relatively new. Most studies to date on OT have utilized plasma measurement, and while a few studies have utilized saliva (Grewen, Davenport, & Light, 2010; White-Traut, Watanabe, Pournajafi-Nazarloo, Schwartz, Bell, & Carter, 2009) and suggested that this method is reliable, there has been report of problems where OT is below the detection of most assays (Carter, et al., 2007; Horvat-Gordon, Granger, Schwartz, Nelson, & Kivlighan, 2005; Nelson, & Kivlighan, 2005). This suggests that this study, or similar hypotheses, should be tested again with plasma OT to ensure the reliability of these findings.

Future Directions

Future studies should explore the relationship between trait mindfulness and self-compassion in conjunction with stressful tasks and look at additional physiological measurements so that the found OT effects can be better understood. In addition, self-report mood data should be taken into account to support the physiological evidence (e.g., perceived threat and challenge). Finally, in order to clear up the differences between trait and state levels of these two variables, future studies should investigate the interactional effects of trait levels and interventions designed to increase them. If more physiological studies are conducted assessing mindfulness and self-compassion in relation to stress and recovery, the results have the potential to alter how clinicians instruct their clients to use mindfulness and self-compassion training surrounding stressful events. A potential clinical take-away message is that self-compassion is more beneficial during times of stress while mindfulness is better suited for periods after stress or during moments of relative stability.

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Table 1

Correlations Between Facets and Total Scores of the Five Factor Mindfulness Questionnaire (FFMQ) and the Self-Compassion Scale (SCS)

Mindfulness Facets						
	Observe	Describe	Acting with Awareness	Non-Judgment	Non-Reactivity	FFMQ Total
FFMQ						
Observe	---	.30**	-.32**	-.22	.25*	.40**
Describe	---	---	.15	.11	.45**	.72**
Acting with Awareness	---	---	---	.48**	.11	.48**
Non-Judgment	---	---	---	---	.139	.56**
Non-Reactivity	---	---	---	---	---	.67**
SCS						
Self-Kindness	.10	.21	.04	.12	.40**	.31**
Self-Judgment	.36**	.05	-.25*	-.42**	-.08	-.11
Common Humanity	.27*	.13	-.19	-.14	.25*	.12
Self-Isolation	.34**	-.07	-.28*	-.32**	-.20	-.17
Mindfulness	.11	.28**	.03	-.06	.41**	.30*
Over-Identify	.30**	-.07	-.51**	-.47**	-.26*	-.34**
SCS Total	-.14	.18	.22	.28*	.37**	.31**

Note. * $p < .05$, two tailed. ** $p < .01$, two tailed.

Table 2

Hierarchical regressions predicting OT levels during Stress and Recovery for 1) Self-Compassion and 2) Mindfulness

DV		Variable Entered	SE	β	Total R ²	ΔR^2	P (of β)
Stress OT							
1	Step 1	Allergy Medication	.17	.55	---	---	.00
		Nasal OT	.16	.52	.70	---	.00
	Step 2	Self Compassion	.12	-.24	.75	.05	.04
2	Step 1	Allergy Medication	.20	.50	---	---	.00
		Nasal OT	.16	.52	.70	---	.00
	Step 2	Mindfulness	.01	-.04	.70	.00	.71
Recovery OT							
1	Step 1	Allergy Medication	.25	-.74	---	---	.00
		Nasal OT	.19	.04	---	---	.81
		Baseline OT	.38	.06	.51	---	.55
	Step 2	Self Compassion	.17	-.11	.52	.01	.55
2	Step 1	Allergy Medication	.25	-.74	---	---	.00
		Nasal OT	.19	.04	---	---	.81
		Baseline OT	.37	.02	.51	---	.93
	Step 2	Mindfulness	.01	-.26	.57	.06	.07

Table 3

Hierarchical regressions predicting OT levels during Stress and Recovery controlling for related Personality and Attachment variables for 1) Self-Compassion and 2) Mindfulness

DV		Variable Entered	SE	β	Total R ²	ΔR^2	P (of β)
Stress OT							
1	Step 1	Allergy Medication	.21	.50	---	---	.00
		Neuroticism	.06	.11	---	---	.35
		Nasal OT	.16	.51	.70	---	.00
	Step 2	Self Compassion	.15	-.24	.75	.05	.05
2	Step 1	Allergy Medication	.21	.56	---	---	.00
		Openness	.07	.19	---	---	.11
		Nasal OT	.16	.45	.73	---	.00
	Step 2	Mindfulness	.02	-.09	.74	.01	.43

Table 4

Hierarchical regressions predicting OT levels during Recovery controlling for related Personality and attachment variables

		<u>Recovery OT</u>					
1	Step 1	Allergy Medication	.24	-.78	---	---	.00
		Nasal OT	.18	.09	---	---	.59
		Baseline OT	.37	.11	---	---	.49
		Neuroticism	.07	.33	---	---	.03
		Secure Attachment	.00	.09	.62	---	.51
	Step 2	Self Compassion	.19	-.01	.62	.00	.97
2	Step 1	Allergy Medication	.27	-.84	---	---	.00
		Nasal OT	.21	.15	---	---	.40
		Baseline OT	.38	.05	---	---	.78
		Openness	.09	-.25	---	---	.13
		Secure Attachment	.00	.11	.56	---	.47
	Step 2	Mindfulness	.01	-.27	.62	.06	.08

Table 5

Self-compassion's association with Stress OT controlling for Openness, Neuroticism, and Mindfulness

DV	Variable Entered	SE	β	Total R ²	ΔR^2	P (of β)
<u>Stress OT</u>						
Step 1	Allergy Medication	.22	.58	---	---	.00
	Nasal OT	.12	.45	---	---	.00
	Openness	.08	.20	---	---	.11
	Neuroticism	.07	.12	.73	---	.30
Step 2	Mindfulness	.01	-.13	.74	.01	.40
Step 3	Self-Compassion	.16	-.25	.78	.04	.05

Table 6

Mindfulness' association with Recovery OT controlling for Neuroticism and Self-Compassion

DV	Variable Entered	SE	β	Total R ²	ΔR^2	P (of β)
<u>Recovery OT</u>						
Step 1	Allergy Medication	.24	-.78	---	---	.00
	Nasal OT	.18	.07	---	---	.67
	Baseline OT	.08	.20	---	---	.11
	Neuroticism	.07	.32	.61	---	.03
Step 2	Self-Compassion	.18	.01	.61	.01	.97
Step 3	Mindfulness	.01	-.21	.64	.02	.23

Table 7

Post hoc analysis of Self-Compassion excluding Mindfulness components (Mindfulness and Over-Identification subscales) and then Mindfulness from the FFMQ was entered in the third step in predicting Stress OT.

DV		Variable Entered	SE	β	Total R ²	ΔR^2	P (of β)
Stress OT							
1	Step 1	Allergy Medication	.20	.50	---	---	.00
		Nasal OT	.16	.52	.70	---	.00
2	Step 2	Self Compassion (excluding <i>mindfulness</i>)	.13	-.23	.73	.03	.09
3	Step 3	Mindfulness	.01	.10	.74	.01	.47

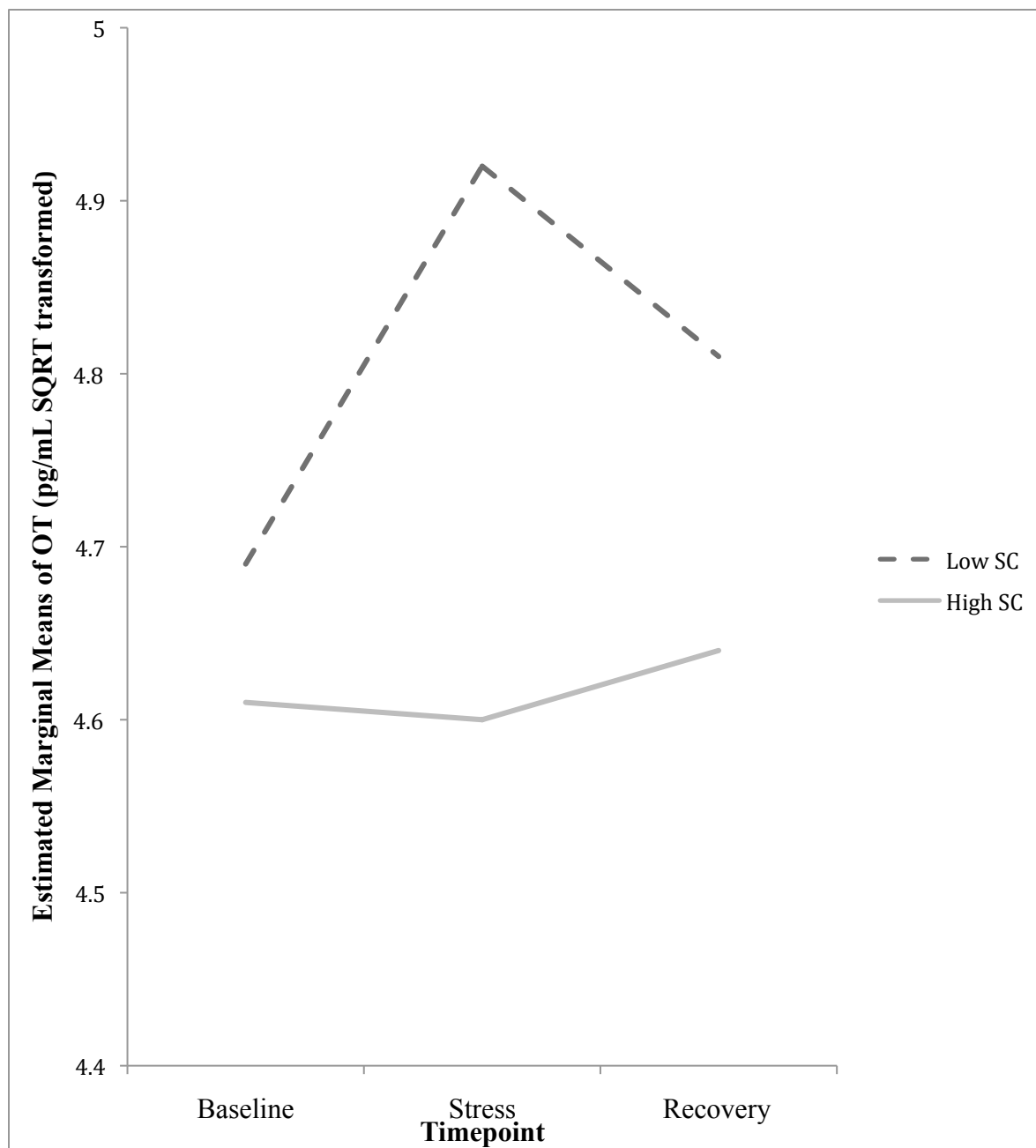


Figure 1. OT trajectories from baseline to stress and recovery for that high and low self-compassion. Self-compassion is divided into high and low levels for figure purposes but was analyzed as a continuous variable.

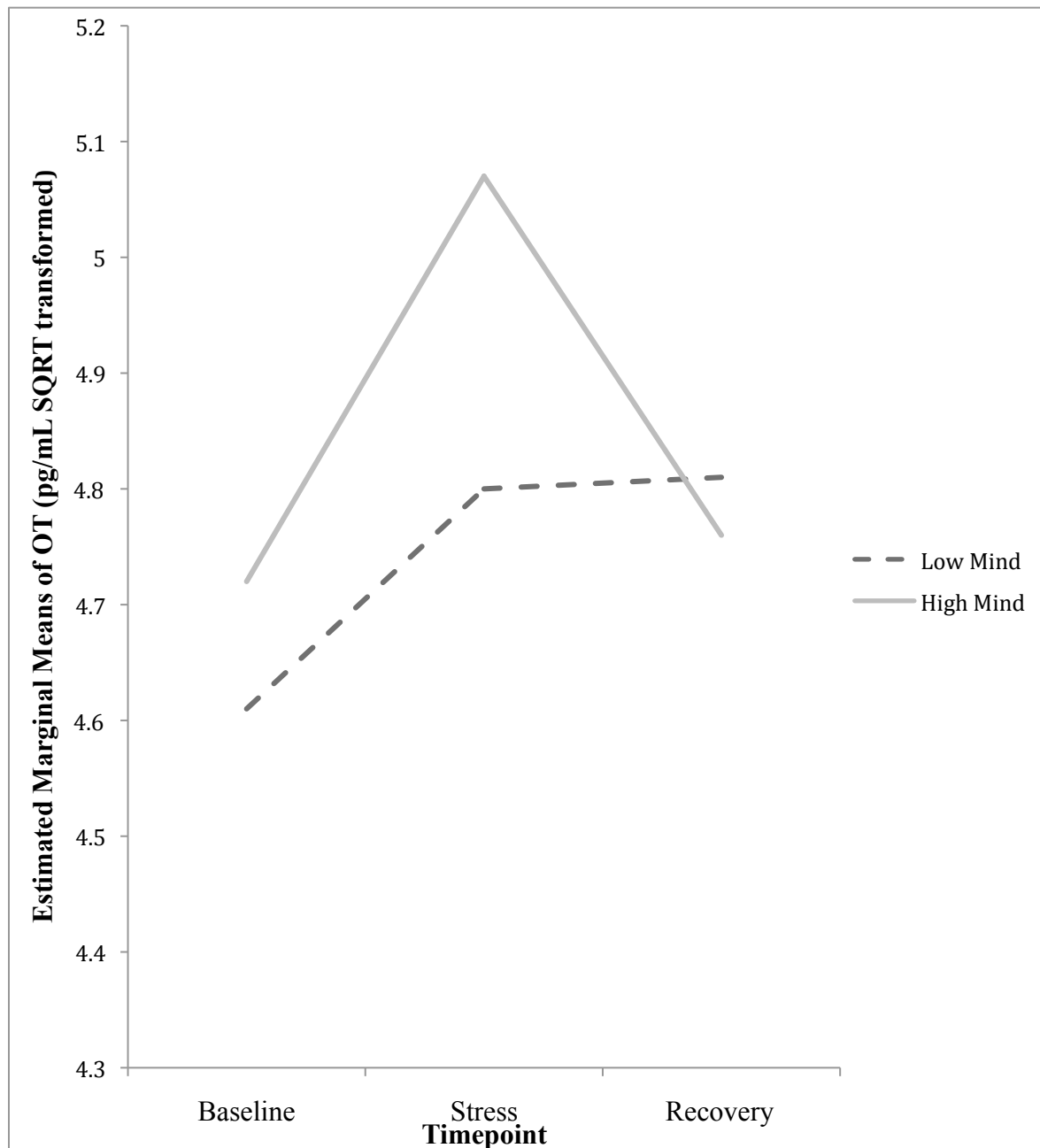


Figure 2. OT trajectories during baseline, stress, and recovery for those high and low in mindfulness. Mindfulness is divided into high and low levels for figure purposes but was analyzed continuously.

Appendix 1: Questionnaires

SCREENING QUESTIONNAIRE: * indicate questions that which will result in exclusion if YES is indicated.

1. Please indicate if you have EVER been diagnosed with or currently have any of the following:

* Asthma(Y/N)

* Hepatitis, Rheumatoid arthritis, Multiple Sclerosis, HIV, or any other autoimmune disease (Y/N) * Thyroid disease, Adrenal Disease or regular steroid use (such as anabolic steroids, prednisone use or corticosteroids) (Y/N)

*A psychological or psychiatric disorder (Y/N) (e.g., depression, schizophrenia, social anxiety disorder)

*Diabetes (Y/N) If Yes, what Type (I/II)

*Chronic sinusitis (Y/N)

*Bronchitis (Y/N)

*Cardiovascular disease (e.g., a heart condition) (Y/N)

*Any other chronic illness (Y/N) (if yes, please specify_____)

*An allergy to tape or adhesive

2. How many alcoholic beverages do you consume in an average week?
(please type Y after the appropriate number of beverages)

0-6 6-12 over 12

3. FOR WOMEN ONLY: Are you currently pregnant or breast feeding? (Y/N) *

4. Please list in the space below ALL medications (both prescribed and over the counter) that you are currently taking (e.g., birth control, antibiotics):

5.

6. Is English your first language? yes no

a. If NO: are you fluent in English and have both fluent understanding & writing ability

YES NO *

Demographics:

1. How old are you? _____ years
2. Are you male or female? _____ male _____ female
3. How would you describe your primary racial or ethnic group?

- _____ (1) White, Caucasian
- _____ (2) Black, African-American
- _____ (3) Native American, Eskimo, Aleut
- _____ (4) Asian or Pacific Islander
- _____ (5) Hispanic, Latino
- _____ (6) Other specify _____

4. Do you currently smoke cigarettes, cigars, or a pipe on a daily basis? ___ yes ___ no

[If YES] 4a. On average, how many of each do you smoke per day?

_____ cigarettes _____ cigars _____ bowls of tobacco

4b. How soon after you wake up do you usually

smoke your first cigarette, cigar, or bowl of tobacco? _____ minutes

If you answered NO to question 4, please answer questions 5 and 6.

5. Did you ever smoke cigarettes, cigars, or a pipe on a daily basis? ___ yes ___ no

[If YES] 5a. When you were smoking your heaviest, how many of each did you smoke on an average day?

_____ cigarettes _____ cigars _____ bowls of tobacco

5b. When did you quit smoking on a daily basis? (month & year) _____

6. Do you currently smoke cigarettes, cigars, or a pipe on a less than daily basis?

___ yes ___ no

[If YES] 6a. What do you smoke? (Check all that apply.)

_____ cigarettes _____ cigars _____ bowls of tobacco

6b. On average, how often do you smoke? _____

6. How many alcoholic beverages do you drink per week (A 4 ounce glass of wine, 12 ounce beer, or shot of hard liquor each equal one drink)? _____

7. At least once a week, do you engage in any regular activity like brisk walking, jogging, bicycling, etc. long enough to work up a sweat or get your heart thumping? ____ yes ____ no

[If YES] 1a. How many times per week? ____ times per week

8. We are interested in the number of flights of stairs you climb UP on average each day. We only want to know the number of flights you climb going UP, not down. Let one flight equal 10 steps if you know the number of steps. ____ flights per day

9. How many city BLOCKS or their equivalent do you walk on average each day? We are only interested in walking done OUT OF DOORS. We do NOT want walking done around the house or at work. If you walk for exercise, report it in the table below, NOT here. Consider that 12 blocks equal 1 mile. _____ blocks per day

10. In the table below, please list any sports or recreational activities in which you participated during the PAST WEEK. These activities can include the activities mentioned in question number 1 above. We are interested only in the time you were physically active.

Sport or recreation during the past week	# of times the past week	Average time per episode	
		Hours	Minutes

11. During the past month, what time have you usually laid down to go to sleep?

Bed time: _____ AM / PM

12. During the past month, what time have you usually gotten up in the morning?

Getting up time: _____ AM / PM

13. On an average night during the past month, how long has it usually taken you to fall asleep after you laid down to go to sleep?

Minutes to fall asleep: _____ minutes

14. On an average night during the past month, how many minutes of sleep did you lose because you woke up in the middle of the night?

Minutes of sleep lost at night: _____ minutes

15. On an average night during the past month, how many minutes of sleep did you lose because you woke earlier than your usual time to get up?

Minutes of sleep lost in morning: _____ minutes

16. During the past month, how would you rate your sleeping quality overall?

_____ (1) very bad _____ (2) fairly bad _____ (3) fairly good _____ (4) very good

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

_____ (1) never
 _____ (2) less than once a week
 _____ (3) once or twice a week
 _____ (4) three or more times per week

18. During the past month, how often have you taken naps during the day?

_____ (1) never
 _____ (2) less than once a week
 _____ (3) once or twice a week
 _____ (4) three or more times per week

FFMQ

Please rate each of the following statements using the scale provided. Write the number in the blank that best describes your own opinion of what is generally true for you.

1	2	3	4	5
Never or very rarely true	Rarely true	Sometimes true	Often true	Very often or always true

_____ 1. When I'm walking, I deliberately notice the sensations of my body moving.

_____ 2. I'm good at finding words to describe my feelings

_____ 3. I criticize myself for having irrational or inappropriate reactions

_____ 4. I perceive my feelings and emotions without having to react to them

_____ 5. When I do things, my mind wanders off and I'm easily distracted

_____ 6. When I take a shower or bath, I stay alert to the sensations of water on my body

_____ 7. I can easily put my beliefs, opinions, and expectations into words

- _____ 8. I don't pay attention to what I'm doing because I'm daydreaming, worrying, or otherwise distracted.
- _____ 9. I watch my feelings without getting lost in them
- _____ 10. I tell myself I shouldn't be feeling the way I'm feeling
- _____ 11. I notice how foods and drinks affect my thoughts, bodily sensations, and emotions.
- _____ 12. It's hard for me to find the words to describe what I'm thinking
- _____ 13. I am easily distracted
- _____ 14. I believe some of my thoughts are abnormal or bad and I shouldn't think that way.
- _____ 15. I pay attention to sensations, such as the wind in my hair or the sun on my face
- _____ 16. I have trouble thinking of the right words to express how I feel about things.
- _____ 17. I make judgments about whether my thoughts are good or bad
- _____ 18. I find it difficult to stay focused on what's happening in the present.
- _____ 19. When I have distressing thoughts or images, I "step back" and am aware of the thought or image without getting taken over by it.

PLEASE TURN OVER

1	2	3	4	5
Never or very rarely true	Rarely true	Sometimes true	Often true	Very often or always true

- _____ 20. I pay attention to sounds, such as clocks ticking, birds chirping, or cars passing.
- _____ 21. In difficult situations, I can pause without immediately reacting
- _____ 22. When I have a sensation in my body, it's difficult for me to describe it because I can't find the right words
- _____ 23. It seems I am "running on automatic" without much awareness of what I'm doing.
- _____ 24. When I have distressing thoughts or images, I feel calm soon after.
- _____ 25. I tell myself that I shouldn't be thinking the way I'm thinking.

- ____ 26. I notice the smells and aromas of things.
- ____ 27. Even when I'm feeling terribly upset, I can find a way to put it into words.
- ____ 28. I rush through activities without being really attentive to them.
- ____ 29. When I have distressing thoughts or images I am able just to notice them without reacting.
- ____ 30. I think some of my emotions are bad or inappropriate and I shouldn't feel them.
- ____ 31. I notice visual elements in art or nature, such as colors, shapes, textures, or patterns of light and shadow.
- ____ 32. My natural tendency is to put my experiences into words.
- ____ 33. When I have distressing thoughts or images, I just notice them and let them go.
- ____ 34. I do jobs or tasks automatically without being aware of what I'm doing.
- ____ 35. When I have distressing thoughts or images, I judge myself as good or bad, depending what the thought/image is about.
- ____ 36. I pay attention to how my emotions affect my thoughts and behavior.
- ____ 37. I can usually describe how I feel at the moment in considerable detail.
- ____ 38. I find myself doing things without paying attention to them.
- ____ 39. I disapprove of myself when I have irrational ideas.

Self-Compassion Scale (SCS)

HOW I TYPICALLY ACT TOWARDS MYSELF IN DIFFICULT TIMES

Please read each statement carefully before answering. To the left of each item, indicate how often you behave in the stated manner, using the following scale:

Almost never					Almost always
1	2	3	4	5	

- ____ 1. I'm disapproving and judgmental about my own flaws and inadequacies.
- ____ 2. When I'm feeling down I tend to obsess and fixate on everything that's wrong.
- ____ 3. When things are going badly for me, I see the difficulties as part of life that everyone goes through.
- ____ 4. When I think about my inadequacies, it tends to make me feel more separate and cut off from the rest of the world.
- ____ 5. I try to be loving towards myself when I'm feeling emotional pain.
- ____ 6. When I fail at something important to me I become consumed by feelings of inadequacy.

- _____ 7. When I'm down and out, I remind myself that there are lots of other people in the world feeling like I am.
- _____ 8. When times are really difficult, I tend to be tough on myself.
- _____ 9. When something upsets me I try to keep my emotions in balance.
- _____ 10. When I feel inadequate in some way, I try to remind myself that feelings of inadequacy are shared by most people.
- _____ 11. I'm intolerant and impatient towards those aspects of my personality I don't like.
- _____ 12. When I'm going through a very hard time, I give myself the caring and tenderness I need.
- _____ 13. When I'm feeling down, I tend to feel like most other people are probably happier than I am.
- _____ 14. When something painful happens I try to take a balanced view of the situation.
- _____ 15. I try to see my failings as part of the human condition.
- _____ 16. When I see aspects of myself that I don't like, I get down on myself.
- _____ 17. When I fail at something important to me I try to keep things in perspective.
- _____ 18. When I'm really struggling, I tend to feel like other people must be having an easier time of it.
- _____ 19. I'm kind to myself when I'm experiencing suffering.
- _____ 20. When something upsets me I get carried away with my feelings.
- _____ 21. I can be a bit cold-hearted towards myself when I'm experiencing suffering.
- _____ 22. When I'm feeling down I try to approach my feelings with curiosity and openness.
- _____ 23. I'm tolerant of my own flaws and inadequacies.
- _____ 24. When something painful happens I tend to blow the incident out of proportion.
- _____ 25. When I fail at something that's important to me, I tend to feel alone in my failure.
- _____ 26. I try to be understanding and patient towards those aspects of my personality I don't like.