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The effects of inducing self-compassion on affective and physiological recovery from a psychosocial stressor in depression

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ABSTRACT

The current study was designed to extend previous research by testing whether self-compassion acts as a protective factor that facilitates faster affective and physiological recovery from stress in people with elevated depressive symptoms. Specifically, we examined the effect of experimentally induced self-compassion on positive affect, negative affect, and respiratory sinus arrhythmia (RSA) recovery from stress. Participants (N = 59) experiencing elevated depressive symptoms completed the Trier Social Stress Test (TSST), a standardized psychosocial stressor, and then were randomly assigned to either a self-compassion induction or a no-strategy control induction before resting quietly during the 30-min recovery period. During the induction period, participants in the self-compassion condition exhibited a greater increase in positive affect and a trend towards a greater decrease in negative affect than did participants in the no-strategy control condition. However, the psychological benefits of self-compassion did not continue during the post-induction recovery period. Moreover, changes in RSA levels did not differ between participants in the self-compassion and no-strategy control condition. These results suggest that, among individuals with elevated depressive symptoms, brief self-compassion inductions have short-term beneficial psychological, but not physiological, effects. As such, our findings delineate the benefits and boundaries of single-session self-compassion inductions in depression, and in doing so, inform future experimental and applied research.

1. Introduction

An extensive body of research documents the role of stress in the onset, maintenance, and recurrence of depression (Hammen, 2005). Yet, despite the frequency with which stressful life events typically occur (Ozer, Best, Lipsey, & Weiss, 2003), a relatively small subset of the population experiences clinically significant depressive symptoms (Kessler et al., 2003). Researchers have shown that the way individuals regulate their emotions following stress plays a central role in determining their emotional recovery, which is vital in protecting against the development and exacerbation of depression (Coifman & Bonanno, 2010; Troy, Wilhelm, Shallcross, & Mauss, 2010). It is, therefore, critical to examine factors that could promote effective recovery from stress.

One factor that has been increasingly examined in connection to stress recovery and depression is self-compassion, a construct with a long tradition in Buddhist teachings. There are three core facets of self-compassion as defined by Neff (2003a): (1) self-kindness – being kind and understanding to oneself instead of being judgmental and self-critical; (2) common humanity – understanding that everyone suffers and identifying with universal suffering; and (3) mindfulness – being aware of painful thoughts and feelings without over-thinking them. The construct of self-compassion has been proposed as an adaptive means of relating to oneself (Neff, Kirkpatrick, & Rude, 2007). Further, it has been suggested that self-compassion may be a resiliency factor that facilitates adaptive stress recovery and, thus, protects against the development and maintenance of depression during times of stress (Ehret, Joormann, & Berking, 2015).

Consistent with this formulation, numerous studies have demonstrated an inverse association between self-compassion and symptoms of depression, with a recent meta-analysis finding a large mean effect size (MacBeth & Gumley, 2012). Further, multiple studies assessing participants with depression have shown that they possess lower levels of self-compassion than never-depressed controls (Ehret et al., 2015; Krieger, Altenstein, Baettig, Doerig, & Holtforth, 2013). Moreover, although experimental studies examining the association between self-compassion and affect in the context of depression are sparse, the two studies that have been conducted both found that participants assigned to a self-compassion induction reported significantly reduced

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depressed mood compared to those assigned to a no-strategy control condition (Diedrich, Grant, Hofmann, Hiller, & Berking, 2014; Ehret, Joormann, & Berking, 2018).

Given the documented benefits of self-compassion on depressed mood (Diedrich et al., 2014; MacBeth & Gumley, 2012), the goal of the current study was to test the boundaries of the benefits of self-compassion in depression by considering other outcome measures. In recent years, research on emotion has increasingly recognized the importance of assessing multiple outcome measures (Scherer, 2004), and this has been recommended with regards to self-compassion specifically (Ehret et al., 2018). For example, theoretical models conceptualize negative and positive affect as distinct and orthogonal constructs (Tellegen, Watson, & Clark, 1999) that are associated with separate domains in the Research Domain Criteria (RDoC) framework (Insel et al., 2010), and researchers have documented that a lack of positive affect is an important and independent predictor of depression (e.g., Gentzler & Root, 2019; Kuhlman et al., 2019). Further, researchers are increasingly incorporating physiological markers of stress to gain a more comprehensive picture of the stress response. Cardiac vagal control is a central physiological marker of stress that has been implicated in risk for depression (Rottenberg, 2007). Cardiac vagal control is often quantified by respiratory sinus arrhythmia (RSA), a measure of variability in heart rate that occurs over the respiration cycle (Porges, 2007). RSA is an important construct to examine as RSA withdrawal is posited to facilitate an individuals' ability to cope with stress by mediating metabolic output to increase heart rate (Porges, 2007). With this in mind, RSA is typically highest during periods of rest, decreases rapidly in times of stress, and then increases to facilitate autonomic recovery (Kreibig, 2010). Depression has been associated with attenuated RSA recovery following stressor offset (Rottenberg, Wilhelm, Gross, & Gotlib, 2003), which is important because prolonged RSA recovery from stress has been linked to adverse cardiac outcomes (Crowell, Skidmore, Rau, & Williams, 2013).

Despite the potential benefits of identifying constructs, like self-compassion, that facilitate affective and RSA recovery from stress, few studies have done so. In fact, the only two experimental studies examining the association between self-compassion and affect in the context of depression measured negative, but not positive, affect, and neither included physiological markers of stress (Diedrich et al., 2014; Ehret et al., 2018).

The current study was designed to extend previous research by testing whether self-compassion acts as a protective factor that facilitates faster affective and physiological recovery from stress in people with elevated depressive symptoms. Specifically, we examined the effect of experimentally induced self-compassion on positive affect, negative affect, and RSA recovery from stress. Consistent with past research (Lee, Mathews, Shergill, & Yiend, 2016; Pictet, Jermann, & Ceschi, 2016), we recruited a sample of individuals who endorsed elevated depressive symptoms as measured by the Beck Depression Inventory- Second Edition (BDI-II). Participants completed the Trier Social Stress Test (TSST), a standardized psychosocial stressor (Kirschbaum, Pirke, & Hellhammer, 1993). They were then randomly assigned to either a self-compassion induction or a no-strategy control induction. Although past research on self-compassion has used a within-subject design where each participant completes each induction, carry-over effects from one induction to the next have been documented (Diedrich, Hofmann, Cuijpers, & Berking, 2016). Thus, we used a between-subject design. Participants' levels of affect and RSA were measured throughout the study. We expected that the self-compassion induction would be significantly more effective than the no-strategy control condition at promoting recovery from stress, as indicated by measures of negative affect, positive affect, and RSA.

2. Methods

2.1. Participants

Participants were 59 adults with elevated symptoms of depression. Participants were recruited from flyers posted in the community, online advertisements posted on community forums, and the student research pool at the University of British Columbia. Individuals participated in the study in exchange for a monetary honorarium or, if they were recruited through the student research pool, for course credit. Individuals were eligible if they were between the ages of 18–65 inclusive, were fluent in English, and passed a two-step screening process that has been used in other studies recruiting depressed participants (e.g., Hakstian & McLean, 1989). Specifically, participants who endorsed at least 5 current symptoms of major depressive disorder from the Diagnostic and Statistical Manual of Mental Disorders, 5th Edition (DSM-5) in an online screener (American Psychiatric Association, 2013) were invited to the laboratory to complete the Beck Depression Inventory – Second Edition (BDI-II; Beck, Steer, & Brown, 1996), and those who reported mild to severe symptoms of depression on the BDI (i.e., BDI-II scores $\geq$ 14 as recommended by Beck et al., 1996) were eligible to participate in the study. The mean age of participants was 20.20 years (SD = 2.56). The majority of participants self-identified as Asian (53%), while 25% identified as White, 3% as Hispanic/Latino, and 19% as other ethnicities.

2.2. Procedure

The present study was approved by the Behavioural Research Ethics Board at the University of British Columbia. After providing informed consent, participants completed the BDI-II to determine eligibility. Eligible participants then watched a 15-min nature video to assess baseline levels of affect and RSA. Next, participants completed a standard psychosocial stressor, the TSST (Kirschbaum et al., 1993). Immediately following the stressor, participants were randomly assigned to complete either a self-compassion induction or no-strategy control induction. Random assignment was conducted using an online random number generator to independently assign each participant the number 1 or 2, which categorized them into the self-compassion or no-strategy control condition. Experimenters were blind to participants' condition. To examine affective and RSA levels following induction offset, participants then completed an unstructured recovery period, during which they sat quietly for 30 min without any distractors. Affect and RSA were collected throughout (as described in the 'Measures' section).

2.3. Psychosocial stressor

To induce a moderate amount of stress, participants completed the TSST (Kirschbaum et al., 1993), a standardized and well-validated psychosocial stressor. Immediately following the baseline nature video, participants were told they would give a 5-min speech to committee members, who would rate their speech quality. Participants had 3 min to prepare their speech, after which time three confederates (two females, one male) entered the room. Participants then gave their speech, during which the confederates maintained a neutral facial expression and provided no feedback. The male confederate asked scripted questions if time remained. After the speech, participants completed an unexpected 5-min mental math task, in which they serially subtracted the number 13 from 1022. Participants were told that their performance was being video recorded in line with standard TSST protocol.

2.4. Stress-response (SR) induction

After completing the stressor, participants were randomly assigned (as described above) to receive one of two stress-response (SR)

Behaviour Research and Therapy 146 (2021) 103965

inductions: self-compassion or a no-strategy control condition. The SR inductions were provided via pre-recorded audio files to ensure consistency across participants, and participants listened to them through headphones connected to a portable MP3 player. Immediately after participants began listening to the audio file, the experimenter left the room; thus, participants listened to the induction while sitting alone in a private room with no distractions. Both SR conditions began the same way, with participants being instructed to think about the kinds of thoughts and feelings they were experiencing as a result of the TSST speech and math task that they had just completed. In the self-compassion induction, participants then received instructions intended to help them achieve a more self-compassionate perspective of their performance during the TSST. The self-compassion instructions were adapted from a guided self-compassion meditation available at self-compassion.org (Neff, 2016) and were consistent with past research on self-compassion inductions (e.g., Diedrich et al., 2014). For example, participants were instructed to give themselves the same kindness, support, and compassion that they would give to a friend who was feeling the same way. In contrast, in the no-strategy control condition, participants were instructed to sit in silence for the remainder of the induction (as is consistent with Diedrich et al., 2014 and Ehret et al., 2018). Both conditions lasted a total of 8 min.

2.5. Measures

Positive and Negative Affect. Self-reported affect was assessed using an adapted version of the Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988). Affect was assessed at 5 time-points: following a 15-min nature video, after the psychosocial stressor, after the stress-response induction, and twice during the recovery period (15- and 30-min post-SR induction). Consistent with past research (Waugh, Muhtadie, Thompson, Joormann, & Gotlib, 2012) negative affect was calculated based on participants' ratings of angry, anxious, and upset, $\alpha = .626$; and positive affect was calculated based on participants' ratings of inspired, happy, and interested, $\alpha = .707$.

Respiratory Sinus Arrhythmia (RSA). RSA was assessed by collecting Electrocardiograph (ECG) and cardiac impedance using frequency-domain analysis. Physiological activity was recorded continuously at a sampling rate of 1 kHz using a MindWare Mobile data acquisition device and Biolab Acquisition Software. To measure ECG, three standard electrodes were attached bilaterally to participants' left and right lower rib cage and right collarbone. To measure impedance, one electrode was placed on the participant's jugular notch and one was placed just below the sternum on the zyphoid process. Two electrodes were placed on the back of the body. The cardiac impedance signal (Z0) is used to validate the RSA data by ensuring that the detected respiration rate falls within the high-frequency band (0.15–0.4 Hz). Data were analyzed using MindWare's BioLab analysis software in 60-s increments. The ECG signal was inspected for artifacts and missing R-peaks (based on improbable interbeat intervals) and were manually corrected. Minute-by-minute estimates of RSA were determined for the baseline period (final 5 min of the nature video), the preparatory period (3 min), the Trier stress period (10 min), the SR induction (8 min), and the recovery period (first 5 min), as is consistent with past research (LeMoult, Yoon, & Joormann, 2016).

Questionnaires. Participants completed the BDI-II (Beck et al., 1996), a 21-item measure used to assess depression severity. The BDI-II was normed on a clinical sample of depressed participants and has shown good reliability and validity (Beck et al., 1996). The BDI-II showed good internal reliability in this sample, $\alpha = .792$. Participants also completed the Self-Compassion Scale – Short Form (SCS-SF; Raes, Pommier, Neff, & Van Gucht, 2011) to assess baseline levels of self-compassion. The SCS-SF includes 12 of the original 26 items (Neff, 2003b) but has a near-perfect correlation with the original measure (Raes et al., 2011). The SCS-SF scale showed good internal reliability within the present sample, $\alpha = .79$.

2.6. Planned analyses

Affect and physiological data were analyzed using multilevel modeling, which allowed us to model at Level 1 repeated measurements of positive affect, negative affect, and RSA within persons as a function of time (Raudenbush & Bryk, 2002). Multilevel modeling is ideal for modeling the nested structure of the data as it does not assume independence of data points and handles varying time intervals between measurements (Hruschka, Kohrt, & Worthman, 2005). For each outcome, we evaluated linear, quadratic, and piecewise models; we then selected the model that best fit the data based on deviance statistics, visual inspection of the data, and the smallest value of Akaikie's Information Criteria (AIC). Next, we tested a series of potential covariates that, based on previous research, might influence responses to stress: age, sex, body mass index (BMI), current use of psychotropic medication, and current use of oral contraceptives (Anderl, Li, & Chen, 2020; Jorm, 1987; Moncrieff, Cohen, & Porter, 2013; O'Regan, Kenny, Cronin, Finucane, & Kearney, 2015; Speed, Jefsen, Børglum, Speed, & Østergaard, 2019; Tonhajzerova et al., 2008; Voss, Schroeder, Heitmann, Peters, & Perz, 2015). We then tested whether between-person variability in Level 1 parameters was explained at Level 2 by characteristics that varied across individuals, namely participants' assigned SR condition, with relevant covariates included in the model. Analyses were run using hierarchical linear modeling software (HLM-7; Raudenbush, Bryk, & Congdon, 2004). Models were fit using full information maximum likelihood for calculating deviance estimates and AIC and using restricted maximum likelihood to estimate model parameters. It has been recommended that for hierarchical models, Level 2 sample sizes should be greater than 50 to achieve adequate power (Maas & Hox, 2005). Further, a power analysis based on a medium effect size for self-compassion (Cohen's $f = .15$) indicated that a sample of 58 participants would be required to detect the hypothesized effect at $\alpha = .05$ and power $= 80\%$ (Soper, 2020). Robust standard errors were used for all analyses to reduce bias, following recommendations put forth by Raudenbush and Bryk (2002). All tests of significance were conducted using two-tailed testing.

Modelling Affect. For both positive and negative affect, the smallest AIC value was associated with the piecewise model (AIC = 1154.77 and 1205.78, respectively), which fit the data significantly better than both the linear and quadratic models, *ps* < .001. The piecewise model estimated affect at baseline (immediately following the 15-min nature video), and during the stress reactivity (baseline to immediately after the stressor), SR induction (immediately after the stressor to immediately after the SR induction), and recovery periods (immediately after the SR induction to 30 min post-induction). Thus, we specified the following Level 1 models (one for positive affect and one for negative affect):

Affect $= \pi_{0j}$ (baseline)+ π_{1j} (stress reactivity) + π_{2j} (SR induction) + π_{3j} (recovery) + e_{ij}

In this equation, π_{0j} represents the level of positive/negative affect for participant j at baseline, π_{1j} represents the slope of change in positive/negative affect during the stressor for participant j (positive values indicate an increase in affect during the stressor; higher values indicate a steeper slope), π_{2j} represents the slope of change in positive/negative affect during the SR induction period for participant j (positive values indicate an increase in affect during the SR induction; higher values indicate a greater increase), π_{3j} represents the slope of change in positive/negative affect across the recovery period for participant j (negative values indicate a decrease in affect during the recovery period; lower values indicate a greater decrease in affect), and e_{ij} represents the within-person random effect for participant j.

We next tested as potential covariates the series of variables described above: age, sex, BMI, current use of psychotropic medication, and current use of oral contraceptives. For positive affect, we found that sex was associated with change in positive affect in response to the stressor, $p = .019$, and both sex and current use of psychotropic medication were associated with change in positive affect across the induction period, $p = .024$ and $p = .007$, respectively. Thus, we included these covariates in the corresponding Level 2 model. We also included condition in all Level 2 equations to examine whether assigned SR condition was associated with individual differences in affect:

Baseline Affect: π_{0j} = B00 + B01 (condition) + r0.

Stress Reactivity: π_{1j} = B10 + B11 (condition) + B12 (sex) + r1.

SR Induction: π_{2j} = B20 + B21 (condition) + B22 (sex) + B23 (psychotropic medication) + r2.

Recovery: π_{3j} = B30 + B31 (condition) + r3.

Of the aforementioned covariates, sex was associated with levels of baseline negative affect, $p = .001$. Thus, for negative affect, we included sex in the corresponding Level 2 model alongside condition:

Baseline Affect: π_{0j} = B00 + B01 (condition) + B02 (sex) + r0.

Stress Reactivity: π_{1j} = B10 + B11 (condition) + r1.

SR Induction: π_{2j} = B20 + B21 (condition) + r2.

Recovery: π_{3j} = B30 + B31 (condition) + r3.

Modelling RSA. For RSA, the smallest AIC was associated with the piecewise model (AIC = 798.72), which estimated RSA stress reactivity (from stress onset to stress offset), SR induction change (induction onset to induction offset), and RSA recovery (initial 5 min of the recovery period), which is in line with previous research (Arch et al., 2014; LeMoult et al., 2016), which fit the data significantly better than both the linear and quadratic models, *ps* < .001. Therefore, we specified the following Level 1 model:

RSA = π_{0j} (baseline) + π_{1j} (RSA reactivity) + π_{2j} (induction change) + π_{3j} (RSA recovery) + e_{ij}

In this equation, π_{0j} represents the level of RSA for participant j at baseline, π_{1j} represents the slope of RSA reactivity for participant j, π_{2j} represents the slope of RSA for participant j across the induction period, π_{3j} represents the slope of RSA recovery for participant j, and e_{1j} represents the within-person random effect for participant j. We then tested a series of variables that have been found to affect RSA in past studies as potential covariates: age, sex, body mass index (BMI), current use of psychotropic medication, and current use of oral contraceptives (O'Regan et al., 2015; Tonhajzerova et al., 2008; Voss et al., 2015). Of these variables, current use of psychotropic medication predicted RSA levels at baseline, $p = .013$; thus, it was included as a covariate in the corresponding Level 2 model. We also included condition in all Level 2 equations to examine whether assigned SR condition was associated with individual differences in RSA:

Baseline RSA: $\pi_{0j} = B_{00} + B_{01}$ (condition) + B_{02} (psychotropic medication) + r_0

RSA Reactivity: $\pi_{1j} = B_{10} + B_{11}$ (condition) + r_1

Induction Change: $\pi_{2j} = B_{20} + B_{21}$ (condition) + r_2

RSA Recovery: $\pi_{3j} = B_{30} + B_{31}$ (condition) + r_3

3. Results

3.1. Demographic and clinical characteristics of participants by condition

Descriptive and clinical characteristics of participants randomly assigned to the self-compassion and control conditions are presented by condition in Table 1. There were no significant differences between the two conditions on age, t (57) = 0.44, $p = .665$, proportion woman, χ^2 (1, $N = 59$) = 0.03, $p = .877$, levels of depression, t (57) = 0.98, $p = .330$, race, χ^2 (7, $N = 59$) = 10.95, $p = .141$, or household income, χ^2 (6, $N = 53$) = 2.27, $p = .893$.

3.2. Effect of condition on positive and negative affect

Positive affect. Positive affect across the psychosocial stressor is presented by condition in Fig. 1. To examine the basic pattern of positive affect across the psychosocial stress task, we first ran a baseline model without any predictors at Level 2. This model indicated that participants' average level of positive affect was significantly different from zero at baseline, B = 3.77, t (58) = 11.83, $p < .001$, and significantly decreased in response to stress onset, B = −0.11, t (58) = −6.97, $p < .001$. Across all participants, level of positive affect remained stable across the induction period, B = 0.02, t (58) = 0.75, $p = .458$, and significantly decreased across the recovery period, B = −0.02, t (58) = −2.21, $p = .031$.

Table 1
Participant characteristics.

Variable	Control Condition (n = 28)	Self-Compassion Condition (n = 31)
Age, *M* (*SD*)	20.36 (2.66)	20.06 (2.50)
Proportion Female	86%	87%
BDI score, *M* (*SD*)	27.18 (7.48)	25.16 (8.19)
SCS score, *M* (*SD*)	2.35 (0.64)	2.45 (0.62)
BMI, *M* (*SD*)	22.71 (3.59)	24.34 (6.15)
Proportion taking psychotropic medication	48%	26%
Proportion taking oral contraceptives	14%	23%
Race		
Aboriginal and White	0%	7%
Asian	64%	42%
Asian and White	7%	0%
Asian and Other	0%	3%
Black and White	4%	0%
White	21%	29%
White and Hispanic or Latino	0%	3%
Other	3%	16%
Household Income		
than $30,000	19%	15%
Between $30,000 & $50,000	7%	8%
Between $50,001 & $70,000	11%	12%
Between $70,001 & $90,000	19%	15%
Between $90,001 & $110,000	7%	15%
Between $110,001 & $130,000	15%	23%
Greater than $130,001	22%	12%

Note. BDI = Beck Depression Inventory; SCS = Self-Compassion Scale.

We then added condition at Level 2 in order to examine whether individual differences in the change in positive affect across the psychosocial stressor were explained by assigned condition. Importantly, condition did not predict baseline levels of positive affect, B = −0.59, t (57) = −0.94, $p = .353$, or changes in positive affect during the stressor, B = 0.04, t (57) = 1.16, $p = .252$, suggesting that random assignment was effective. However, as expected, change in positive affect differed significantly by condition during the SR induction, B = 0.10, t (57) = 2.48, $p = .016$, and recovery period, B = −0.04, t (57) = −2.31, $p = .025$. For participants in the self-compassion condition, positive affect increased during the self-compassion induction, B = 0.16, t (28) = 2.20, $p = .037$, and then decreased following offset of the induction, B = −0.04, t (30) = −2.73, $p = .010$. In contrast, for participants in the no-strategy condition, positive affect did not change during the SR induction, B = −0.04, t (27) = −1.71, $p = .098$, or recovery period, B = −0.0001, t (27) = −0.01, $p = .994$.

We then conducted exploratory analyses to examine whether levels of baseline self-compassion moderated the effect of condition on levels of positive affect across the psychosocial stressor by adding baseline self-compassion scores and the interaction between baseline self-compassion and condition to all Level 2 equations. This analysis yielded a significant interaction between self-compassion and condition during the SR induction, B = 0.12, t(51) = 2.05, $p = .045$. Follow-up tests indicated that, among those in the self-compassion condition, higher levels of baseline self-compassion were associated with a greater increase in positive affect during the SR induction, B = 0.12, t (26) = 2.66, $p = .013$, suggesting that the self-compassion induction was more effective for those with higher levels of baseline self-compassion. In contrast, within the no-strategy control condition, levels of baseline self-compassion were not

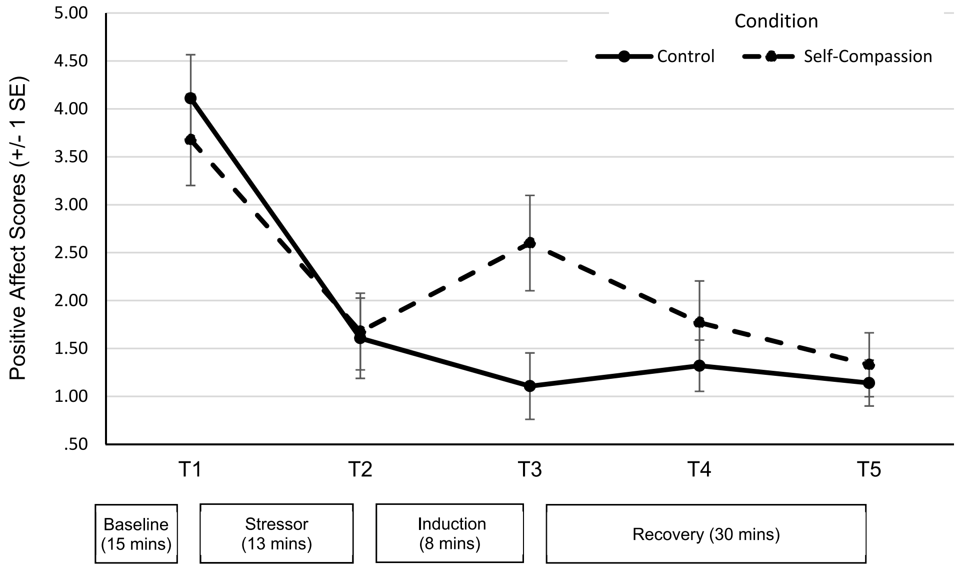

Fig. 1. Positive affect ratings for participants in the control and self-compassion conditions. Error bars indicate ± 1 standard error.

associated with change in positive affect during the SR induction, $B = 0.02$, $t\ (23) = 0.64$, $p = .531$.

We also conducted exploratory analyses on each positive affective state separately. Positive affect was comprised of participants' ratings of inspired, happy, and interested. As expected, condition did not predict baseline levels or stress-reactivity changes in any positive affect state, *ps* $> .272$. However, during the SR induction, increases in inspiration and happiness were greater in the self-compassion condition than the no-strategy control condition, *ps* $< .025$. Subsequent decreases in inspiration and happiness during the recovery period were also greater in the self-compassion condition than the no-strategy control condition, *ps* $< .048$. In contrast, levels of interest during the psychosocial stressor did not differ between conditions at any point, *ps* $> .089$. See the online supplement for additional details.

Negative affect. Negative affect across the psychosocial stressor is presented by condition in Fig. 2. To investigate the basic pattern of negative affect across the psychosocial stressor, we first ran a baseline model without any predictors at Level 2. This baseline model indicated that participants' average level of negative affect was significantly different from zero at baseline, $B = 1.57$, $t\ (58) = 8.87$, $p < .001$, significantly increased in response to the stressor, $B = 0.23$, $t\ (58) = 10.22$, $p < .001$, significantly decreased across the induction period, $B = -0.15$, $t\ (58) = -6.55$, $p < .001$, and significantly decreased across the recovery period, $B = -0.06$, $t\ (58) = -5.51$, $p < .001$.

Participants in the self-compassion condition and the no-strategy control condition did not differ in negative affect at baseline, $B = 0.38$, $t\ (56) = 1.12$, $p = .267$, or in negative affective reactivity during the stressor, $B = -0.01$, $t\ (57) = -0.31$, $p = .758$, providing further support that random assignment was effective. However, as expected, decreases in negative affect during the SR induction were greater in the self-compassion condition compared to the no-strategy control condition at a trend level, $B = -0.09$, $t\ (57) = -1.96$, $p = .055$, with decreases in negative affect reported in both the self-compassion, $B = -0.19$, $t\ (30) = -5.16$, $p < .001$, and no-strategy control conditions, $B = -0.11$, $t\ (27) = -4.38$, $p < .001$. Following offset of the SR induction, change in negative affect did not differ across conditions, $B = 0.03$, $t\ (57) = 1.34$, $p = .184$. Exploratory analyses indicated that levels of baseline self-compassion did not moderate the effect of condition on change in negative affect across the psychosocial stressor, *ps* $> .119$.

We then conducted exploratory analyses on each negative affective state separately. Negative affect was comprised of participants' ratings of angry, anxious, and upset. At baseline, levels of anger were higher in

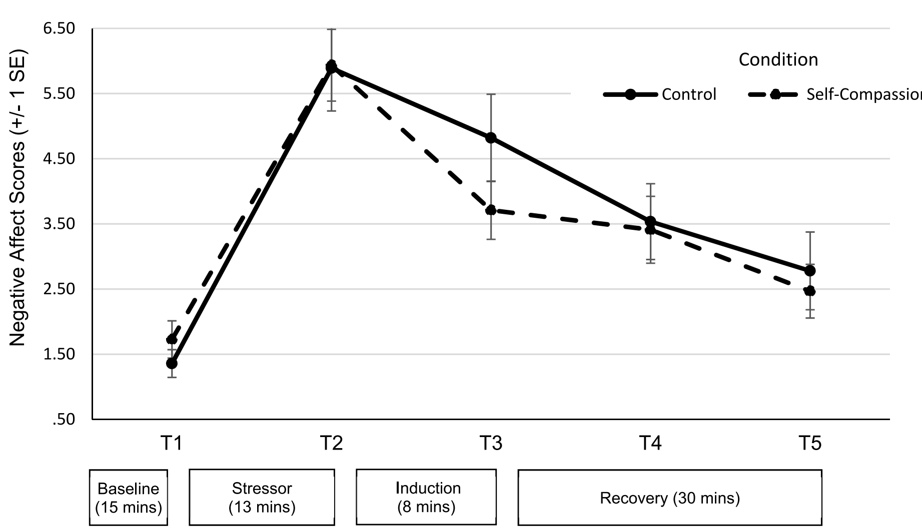

Fig. 2. Negative affect ratings for participants in the control and self-compassion conditions. Error bars indicate ± 1 standard error.

the self-compassion condition than the no-strategy control condition, $p = .034$, but changes in anger during the stressor, SR induction, and recovery period did not differ between conditions, $ps > .132$. In addition, ratings of anxious and upset affect did not differ at any point, $ps > .092$. See the online supplement for additional details.

3.3. Effect of condition on RSA

RSA across the psychosocial stressor is presented by condition in Fig. 3. To examine the basic pattern of RSA response across the stressor, a baseline model without any predictors at Level 2 was conducted. This model demonstrated that participants average level of RSA at baseline differed significantly from zero, $B = 6.38$, $t\ (54) = 47.04$, $p < .001$. Across all participants, levels of RSA then significantly decreased in response to stress onset, $B = -0.06$, $t\ (54) = -5.78$, $p < .001$, significantly increased across the induction period, $B = 0.14$, $t\ (54) = 6.49$, $p < .001$, and finally remained stable across the recovery period, $B = 0.03$, $t\ (54) = 0.62$, $p = .540$.

Contrary to expectations, SR condition did not predict RSA levels at baseline, RSA reactivity, changes in RSA across the induction period, or RSA recovery, $ps > .651$. Further, exploratory analyses indicated that levels of baseline self-compassion did not moderate the effect of condition on change in RSA across the psychosocial stressor, $ps > .071$.

4. Discussion

The current study is the first to experimentally investigate whether self-compassion was more effective than a control condition at promoting recovery from stress in the context of depression as indicated by levels of positive affect, negative affect, and RSA. Participants with elevated depressive symptoms completed a psychosocial stressor and were then randomly assigned to a self-compassion or a no-strategy control condition. We found that, across conditions, participants experienced the expected affective and physiological responses to the stressor. Importantly, we also found that, over and above this within-person change, the SR condition influenced participants' affective recovery from the stressor. As expected, participants in the self-compassion condition exhibited a greater increase in positive affect and a trend towards a greater decrease in negative affect during the SR condition than did participants in the no-strategy control condition. In contrast, however, changes in RSA levels did not differ between participants in the self-compassion and no-strategy control condition. These findings provide insight into the degree to which self-compassion promotes effective recovery from stress in participants with elevated depressive symptoms.

Our findings are the first to show that engaging in self-compassion after a stressor improves positive affect – particularly feelings of inspiration and happiness – in participants with elevated depressive symptoms. These results support correlational research documenting that higher levels of self-compassion are associated with higher levels of positive affect in daily life (Krieger, Hermann, Zimmermann, & Grosse Holtforth, 2015). To our knowledge, however, this is the first study to assess levels of positive affect in participants with elevated depressive symptoms in response to an experimental self-compassion induction in the laboratory. There are far-reaching benefits to increasing positive affect in people experiencing depressive symptoms. As many as a third of depressed individuals have clinically significant levels of low positive affect, or anhedonia (Pelizza & Ferrari, 2009), which has been shown to predict a poorer course of depression in a number of prospective studies (Gentzler & Root, 2019; Kuhlman et al., 2019). There is a longstanding theoretical and empirical literature distinguishing positive and negative affect (Clark & Watson, 1991) and linking them to the approach versus withdrawal systems, respectively (Davidson, 2003). Although treatment for depression has traditionally focused on reducing negative affect, researchers have increasingly examined the role of targeting positive affect (Craske, Meuret, Ritz, Treanor, & Dour, 2016) and findings from our work suggest that future research might continue to explore whether self-compassion facilitates changes in both negative and positive affect domains. Future research might also test whether individual-difference factors determine the duration of effectiveness of self-compassion inductions in the context of depression. Our exploratory analyses indicated that the self-compassion induction was more effective at increasing positive affect for participants' with higher levels of baseline self-compassion. This finding is consistent with other research that found inductions were most effective when there was a match between induction type and participants' characteristics (Shull et al., 2016).

Another important strength of our study is that we assessed responses to stress both during the stress-response induction and 15- and 30-min after induction offset. Past research examining the effects of self-compassion on responses to stress has focused on the induction period exclusively. By assessing the effects of self-compassion post-induction, we gain additional information about how depressed individuals recover from stress and the duration over which one single training of self-compassion can influence affect. Interestingly, the benefits of the self-compassion induction were specific to when participants were engaged in self-compassion and were not observed during the post-

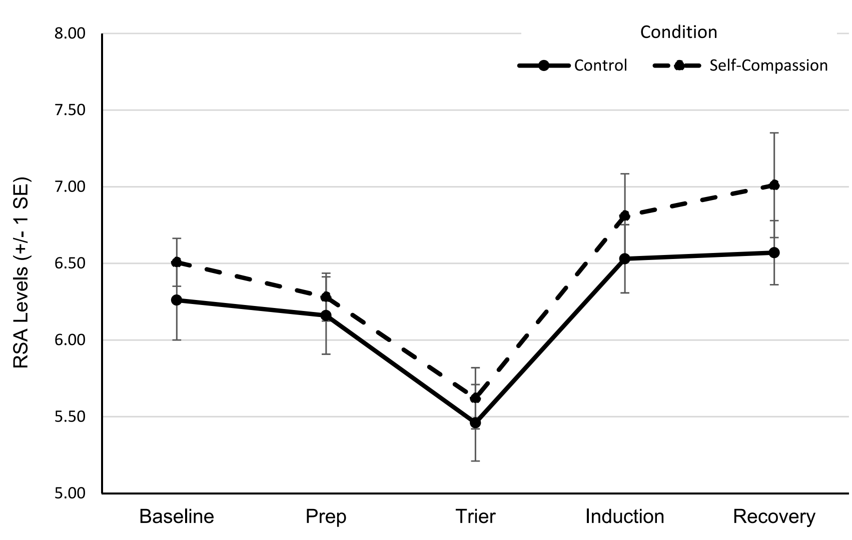

Fig. 3. RSA levels for participants in the control and self-compassion conditions. Error bars indicate ± 1 standard error.

induction recovery period. One potential reason for the short duration of effects is that the induction was simply too short-lived. A single-session, brief self-compassion instruction may not be sufficient to promote longer-term changes in affect for people with elevated depressive symptoms. This possibility can inform future research on self-compassion inductions and can encourage future studies to consider the short-term and long-term dose-response association. It is also important to keep in mind that, during the recovery period, we asked participants to sit quietly without engaging in any activity. We made this decision in order to examine participants' natural post-induction recovery, which could have been altered by even passive activities (Blagden & Craske, 1996). However, this type of recovery period may have led to participants' feeling bored, which can limit experimental manipulations (Bornstein, Kale, & Cornell, 1990) and may explain why levels of positive affect declined during the recovery period.

It is also of note that the self-compassion induction was not more effective than the control condition at promoting RSA recovery from stress in our sample of individuals with elevated depressive symptoms. Interestingly, this observation is consistent with evidence that individuals high in trait self-compassion do not differ significantly from those low in trait self-compassion in several biological markers of stress recovery, including markers of the autonomic and neuroendocrine systems (Bluth et al., 2016). Research assessing the influence of other emotion regulation strategies on RSA levels have also failed to find significant effects (Campbell-Sills, Barlow, Brown, & Hofmann, 2006; Kuo, Fitzpatrick, Metcalfe, & McMain, 2016). For example, Campbell--Sills et al. (2006) randomly assigned individuals diagnosed with anxiety and mood disorders to a single 5-min suppression or acceptance induction, and they found no difference in RSA changes between the two groups. Thus, it may be more difficult to "move the needle" on biological markers of stress via single-session inductions because other factors, such as homeostatic reflexes, influence biological functioning (Hyndman, 1974). It is also important to consider our results in light of the fact that RSA levels are highest during non-stressed or relaxed states. In fact, greater effort has long been associated with parasympathetic withdrawal (Luft, Takase, & Darby, 2009; Lundberg & Frankenhaeuser, 1980), and researchers have documented RSA withdrawal when using effortful emotion regulation inductions and tasks (LeMoult et al., 2016; Reynard, Gevirtz, Berlow, Brown, & Boutelle, 2011). Thus, the effort of applying self-compassion may have influenced RSA levels during the SR induction. The benefits of self-compassion on RSA may only be observed once self-compassion becomes easier, for example through multiple training sessions. Supporting this possibility, Arch and colleagues found that participants who received multiple sessions of self-compassion training experienced a reduced RSA stress response compared to those in the no-strategy control condition (Arch et al., 2014).

It is important to acknowledge the limitations of this study and to identify areas for future research. Although participants in the current study did not meet criteria for major depressive disorder (MDD), levels of self-compassion scores at baseline ($M = 2.4$) were consistent with what other researchers have documented in samples of participants with MDD ($M = 2.2$ in Van Dam, Sheppard, Forsyth, & Earleywine, 2011; $M = 2.74$ in Körner et al., 2015). Nonetheless, future research should be conducted in a clinical sample in order to examine whether the findings reported here are observed in MDD. In addition, a limitation of our study design is that we did not assess what participants were thinking about following the SR induction period. Assessing participants' thought content during the unstructured recovery period might allow us to better understand why the benefits of the self-compassion induction did not continue during the post-induction recovery period. Further, there are certain limitations inherent with including university student participants, particularly when students participate in exchange for course credit. The majority of participants in the current study received course credit instead of a monetary incentive; thus, they may have been less attentive or careful in their participation. However, all participants correctly answered attention-check question, attenuating concerns about careless responding. Another limitation is that our sample was primarily female, restricting the generalizability of our findings. Future research should recruit a sample with a larger proportion of males in order to ensure findings generalize across sexes and to test whether sex moderates the findings reported here.

The current study is an important addition to the burgeoning literature examining self-compassion as it relates to stress and depression. This study extends the research in several ways. It is the first to show that inducing self-compassion supports responses to stressors as measured by positive affect. It is also the first to document that the benefits of the self-compassion induction on affect were not present 15 or 30 min after induction offset. In addition, evidence that participants in the self-compassion and no-strategy control induction did not differ in RSA recovery from stress provides insight about the limited benefits of a single-session self-compassion induction. These findings expand our understanding of self-compassion and its impact on responses to stress in the context of elevated depressive symptoms. Given the discrepant results between affective and physiological outcomes, further research is needed to determine whether self-compassion is an effective technique for promoting effective biological recovery from stressors. It may take more time to cultivate and internalize self-compassion. This finding will be important to examine further in order to inform future inductions and experimental work.

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Credit author statement

Alison Tracy: Conceptualization, Methodology, Investigation, Writing – original draft preparation, Project administration. Joelle LeMoult.: Conceptualization, Methodology, Formal analysis, Writing-Reviewing and Editing, Supervision, Funding acquisition. Ellen Jopling: Formal analysis, Writing – review & editing, Visualization.

Declaration of competing interest

None.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.brat.2021.103965.

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