Predictors and moderators of biopsychological social stress responses following brief self-compassion meditation training

Joanna J. Arch [a],[*],[1], Lauren N. Landy [a],[1], Kirk Warren Brown [b]

[a] Department of Psychology and Neuroscience, University of Colorado Boulder, 345 UCB Muenzinger, Boulder, CO 80309-0345, United States
[b] Department of Psychology, Virginia Commonwealth University, 806 West Franklin Street, Richmond, VA 23284-2018, United States

ARTICLE INFO

ABSTRACT

Arch et al. (2014) demonstrated that brief self-compassion meditation training (SCT) dampened sympathetic (salivary alpha-amylase) and subjective anxiety responses to the Trier Social Stress Test (TSST), relative to attention and no-instruction control conditions. The present study examined baseline predictors and moderators of these SCT intervention effects. Baseline characteristics included two stress vulnerability traits (social anxiety and rumination) and two potential resiliency traits (non-attachment and self-compassion). We investigated how these traits moderated the effects of SCT on response to the TSST, relative to the control conditions. We also tested how these individual differences predicted TSST responses *across* conditions in order to uncover characteristics that confer increased vulnerability and resiliency to social stressors. Trait non-attachment, rumination (for sympathetic TSST response only), and social anxiety (for subjective TSST response only) interacted with training condition to moderate TSST responses such that following SCT, lower attachment and lower social anxiety predicted lower TSST stress responses, relative to those scoring higher on these traits. In contrast, trait self-compassion neither moderated nor predicted responses to the TSST. Thus, although SCT had robust effects on buffering stress across individuals with varying levels of trait self-compassion, other psychological traits enhanced or dampened the effect of SCT on TSST responses. These findings support the importance of examining the role of relevant baseline psychological traits to predict sympathetic and subjective responses to social evaluative threat, particularly in the context of resiliency training.

© 2016 Elsevier Ltd. All rights reserved.

1. Introduction

1.1. Background

There has been a growing interest in interventions that promote resilience to social stress. For example, intensive stress management (Hammerfald et al., 2006) and personal values affirmation (Creswell et al., 2005) have been shown to dampen cortisol responses to the Trier Social Stress Task (TSST) (Kirschbaum et al., 2008), which reliably evokes a cortisol response (Dickerson et al., 2004). Contemplative interventions also have shown promise in promoting resilience. For example, Arch et al. (2014) found that brief self-compassion meditation training diminished sympathetic nervous system (salivary alpha amylase) and subjective anxiety responses to the TSST, within a sample of young women.

Yet even following training, individuals differ in response to the same social stressor (Chida and Hamer, 2008). This question of *for whom* interventions are effective is long-standing in medicine and psychology (e.g. Norcross and Wampold, 2011). With several exceptions (e.g., Creswell et al., 2014; Hammerfald et al., 2006), little research has examined how individual differences can moderate social stress resilience training outcomes. The present study assessed such boundary conditions, using self-compassion training (SCT) as a model; this training has shown considerable promise in boosting social stress resilience (e.g., Arch et al., 2014; Pace et al., 2009; Leary et al., 2007). Specifically, Arch et al. (2014) showed that SCT, consisting of a brief lovingkindness or *metta* meditation practiced everyday for three days and again prior to receiving the TSST instructions, resulted in lower salivary alpha-amylase (sAA) and state anxiety responses to the TSST, compared to attention-control

* Corresponding author.
  E-mail addresses: Joanna.Arch@Colorado.edu (J.J. Arch),
Lauren.Landy@Colorado.edu (L.N. Landy), kwbrown@vcu.edu (K.W. Brown).
  [1] These authors contributed equally to the paper.

and no intervention control conditions.[1] The current study represents a secondary analysis of Arch et al. (2014) in which we assess *for whom* SCT is most beneficial—that is, we explore the boundary conditions of the original findings.

In asking for whom SCT is most likely to be beneficial, we put forth competing hypotheses: One possibility is that a predisposition toward self-compassion, reflected in higher trait self-compassion, will lead to greater benefit from SCT because self-compassion can be taught more readily to those already higher in this trait (Gilbert et al., 2011); a competing possibility is that those lower in trait self-compassion will stand to benefit the most from SCT because they have more room to increase in self-compassion (and a greater need for such training; e.g., Gilbert and Procter, 2006). Further, theory and research (Sahdra et al., 2010) suggest that higher non-attachment, reflecting less fixation on achieving particular outcomes, would predispose to lower TSST stress-related emotional and sympathetic outcomes and that this predisposition might be potentiated by training in self-compassion. Conversely, we hypothesized that following SCT, higher trait social anxiety and rumination would predict higher social stress reactivity within this condition (Condren et al., 2002; Young and Nolen-Hoeksema, 2001) relative to lower trait social anxiety and rumination, as these dispositions appear to reflect less openness to key SCT elements (Gilbert et al., 2011), potentially reducing training impact (at least in the context of brief training).

1.2. The present research

Extending Arch et al. (2014)'s investigation of SCT, we investigated how these four baseline characteristics differentially predict SCT response to the TSST relative to two control conditions. Secondarily, we tested how these individual differences predict TSST responses *across* conditions to uncover characteristics that confer increased vulnerability and resilience to social stressors. Salivary cortisol, reflecting HPA axis activity, is a commonly studied neuroendocrine marker of TSST response. However, sympathetic nervous system activity markers, particularly the protein salivary alpha amylase (sAA), have shown sensitivity to TSST demands (Nater et al., 2006), and Arch et al. (2014) found that this outcome, along with subjectively-experienced emotion, showed particular responsiveness to SCT. Investigations of sAA response to the TSST are growing (see Ref. Nater and Rohleder, 2009), and generally suggest that lower sAA levels correspond with lower stress levels (both perceived and objective stress). In accord with this, in our original investigation (Arch et al., 2014), the SCT group showed the lowest sAA as well as the lowest subjective anxiety levels in response to the TSST, relative to active and passive conditions. Thus, in studying the boundary conditions of the significant effects of SCT on sAA and subjective anxiety TSST responses in the Arch et al. (2014) study, the present study examined how the four traits of interest predicted these two TSST outcomes.

2. Material and methods

2.1. Participants

One hundred five physically healthy undergraduate women reporting no medication or oral contraception use completed the TSST; seven were excluded due to missing outcome data. Women

received course credit or payment. IRB approval and informed consent were obtained. See Ref. Arch et al. (2014) for further details.

2.2. Experimental conditions

Participants were randomized to SCT, attention (placebo) control, or no intervention. SCT used recorded 10-min self-focused lovingkindness meditations to cultivate self-kindness/compassion. The attention control used recorded 10-min. excerpts from a cognitive psychology textbook used to control for attention and placebo effects of listening to a recording with content plausibly relevant to TSST preparation, including discussions of problem solving, judgment, and thinking (see Ref. Arch et al., 2014). No recordings were used in the no-intervention condition to provide a control condition that allowed for a "natural" response to the TSST without intervention, to compare to the effects of SCT. To reflect the statistical approach in the original paper and reduce the need for post-hoc condition testing (Arch et al., 2014), we retained the *a priori* contrast codes that compared (a) each control condition, to confirm a lack of difference between the two control conditions. This variable was labeled "Group 1"; and (b) the control conditions to the SCT condition. This variable was labeled "Group 2" and represented the contrast code of interest. However, both contrast codes were included in all analyses, thereby accounting for differences between the two control conditions when examining the difference between the control conditions and the SCT condition.

2.3. Design and procedures

Two sessions were scheduled 4 days apart. In session 1 (s1), individual difference measures (below) were completed. Those in the self-compassion and attention control conditions were introduced to a 10-min, condition-specific recording and instructed to attentively listen to a "similar recording" accessed via a secure website daily for the next 3 days (and monitored by the experimenter to confirm completion). Session 2 (s2; TSST session) was scheduled between 1- 6pm. Following a 30 min baseline period, participants were told: "The rest of the study will be challenging." Women in the active conditions were additionally told, "To help you prepare for the challenge, we invite you to listen to a recording similar to the ones you listened to at home," followed by a 5-min condition-specific recording. TSST followed canonical procedures (Kirschbaum et al., 2008), excepting a 5-min (rather than 10-min) speech anticipation period.

2.4. Measures

2.4.1. Individual differences
Self-compassion was assessed with the validated, 26-item Self-Compassion Scale (SCS; Neff, 2003), measuring tendencies to be kind toward oneself, connected to a common sense of humanity, and mindfully aware of painful thoughts and feelings (current study $\alpha = 0.94$).

Non-attachment was measured with the 30-item Non-attachment Scale (NAS; Sahdra et al., 2010; example item: "I can accept the flow of events in my life without hanging onto them or pushing them away."). The NAS has strong convergent and discriminant validity and one month test-retest reliability ($r = 0.87$); study $\alpha = .92$.

Social Anxiety during social interactions was assessed with the well-validated, 20-item Social Interaction Anxiety Scale (SIAS; Mattick and Clarke, 1998); study $\alpha = 0.92$. The SIAS was square root transformed to normalize its distribution prior to analysis.

---

[1] Of note, our *metta* meditation-based approach to SCT differs from the more intensive mindful self-compassion training program developed by Neff and Germer (2013) as well as the traditional Tibetan mind-training practices (*lojong*) studied by Pace et al. (2009).

Rumination was assessed with the 12-item rumination subscale of the Rumination Reflection Questionnaire (RRQ; Trapnell and Campbell, 1999); study α = 0.91.

2.4.2. TSST outcomes

2.4.2.1. Salivary alpha amylase (sAA). Saliva was collected at five points during s2: baseline, immediately post-TSST, 10 min post-TSST, 20 min post-TSST, and 35 min post-TSST. However, sAA levels returned to baseline by 20 min post-TSST (see Ref. Arch et al., 2014) as sAA is known to react and recover more quickly than cortisol (Rohleder et al., 2004; Nater et al., 2005). Thus, we focused analyses on the first four sAA collection points (baseline to 20 min post-TSST). Samples were stored in a −15 °C freezer; all samples from the same subject were processed in the same assay. Samples were assessed by kinetic assay (Salimetrics; State College, PA) and run in singlet, diluted 1:200. Inter- and intra- assay coefficients of variability for sAA samples were 4.7 and 11.3%, respectively.

2.4.2.2. State Anxiety. The widely-used Subjective Units of Distress Scale (SUDS; Wolpe, 1990) assessed state anxiety on a 0–100 scale, at the same points as sAA plus one additional time during the TSST preparation period. Thus, to match the time frame of the sAA analyses and capture the period of greatest SUDS reactivity and recovery, we focus on the SUDS ratings from baseline to 20 min post-TSST.

2.5. Statistical approach

We constructed hierarchical linear models in HLM 7.0 to model time-varying outcomes and random effects. We included linear and quadratic terms at level 1 to capture linear and curvilinear responses of sAA and SUDS to the TSST. *A priori* contrast coding was used to compare the two control conditions to the self-compassion condition (see Section 2.2, above). All putative moderators were centered prior to entry in the model or computation of interaction terms. As presented in Table 1, the putative trait moderators, assessed at baseline, and the trait × condition interactions were included at level 2 of each model. As recommended when examining higher order interactions, all lower order main effects and interactions were included in the model. Although this necessitated including many lower order terms, we focused on those that directly tested our hypotheses. Thus, the primary moderator term of interest was the higher order (quadratic) time × trait × Group 2 interaction (see Table 1), which indicated whether SCT, relative to the two control conditions, produced a significantly different curvilinear pattern of change in sAA or SUDS in response to the TSST. We were also interested in the trait × Group 2 interaction on the intercept, which, in the absence of interaction with time, would indicate a stable difference in the influence of the trait moderator on TSST responses between the SCT versus control conditions. If the putative moderator interactions were non-significant, the model was recalculated without them to test whether the putative moderator instead served as a predictor, that is, whether it affected TSST response *across* conditions. For predictor analyses, the predictor x quadratic time interaction represented the key effect of interest, indicating that the predictor influenced the curvilinear rate of change in TSST responses (c.f. Brown et al., 2012).

3. Results

3.1. Moderator and predictor findings

Trait self-compassion neither moderated intervention condition effects on sAA or SUDS at any time point, nor did trait self-compssion predict sAA responses across conditions, $ps > 0.16$. However, higher trait self-compassion predicted lower SUDS ratings at the intercept, $b = −0.20$, $p = 0.01$, suggesting a main effect

Table 1
Variables Included in the HLM Moderator Analyses (on Level 2).

Trait Predictor/Moderator	Variables included in the model (for each sAA and SUDS rating outcomes)
1. Self-compassion	Intercept: Group1 Group2[*] Self-compassion[*] Self-compassion × Group1 Self-compassion × Group2 Linear slope: TIME × Self-compassion TIME × Group1 TIME × Group2[*,**] TIME × Self-compassion x Group1 TIME × Self-compassion x Group2 Quadratic slope: $TIME^2$ × Self-compassion $TIME^2$ × Group1 $TIME^2$ × Group2[*] $TIME^2$ × Self-compassion × Group1 $TIME^2$ × Self-compassion × Group2
2. Non-attachment	Intercept: Group1 Group2[*] Non-attachment[*] Non-attachment × Group1 Non-attachment × Group2 Linear slope: TIME × Non-attachment TIME × Group1 TIME × Group2[*,**] TIME × Non-attachment × Group1 TIME × Non-attachment × Group2[*,**] Quadratic slope: $TIME^2$ × Non-attachment $TIME^2$ × Group1 $TIME^2$ × Group2 $TIME^2$ × Non-attachment x Group1 $TIME^2$ × Non-attachment x Group2[*,**]
3. Social anxiety	Intercept: Group1 Group2 Social anxiety[*] Social anxiety × Group1 Social anxiety × Group2[*] Linear slope: TIME × Social anxiety[**] TIME × Group1 TIME × Group2 TIME × Social anxiety × Group1 TIME × Social anxiety × Group2 Quadratic slope: $TIME^2$ × Social anxiety[**] $TIME^2$ × Group1 $TIME^2$ × Group2 $TIME^2$ × Social anxiety × Group1 $TIME^2$ × Social anxiety × Group2
4. Rumination	Intercept: Group1 Group2[*] Rumination[*] Rumination × Group1 Rumination × Group2 Linear slope: TIME × Rumination TIME × Group1 TIME × Group2[*,**] TIME × Rumination × Group1 TIME × Rumination × Group2 Quadratic slope: $TIME^2$ × Rumination $TIME^2$ × Group1 $TIME^2$ × Group2[*,**] $TIME^2$ × Rumination × Group1 $TIME^2$ × Rumination × Group2[**]

Note: The main effects of interest were the $TIME^2$ x Trait x Group2 moderator effect and if nonsignificant, then the $TIME^2$ × Trait predictor effect. All trait variables were centered prior to entering them into the model as main effects and prior to creating the interaction terms. Group 1 = contrast code 1 in which the attention control group was compared to the no-instruction control group, Group 2 = contrast code 2 in which the self-compassion training group was compared to the control groups.

[*] indicates $p < .05$ finding for the SUDS outcome.
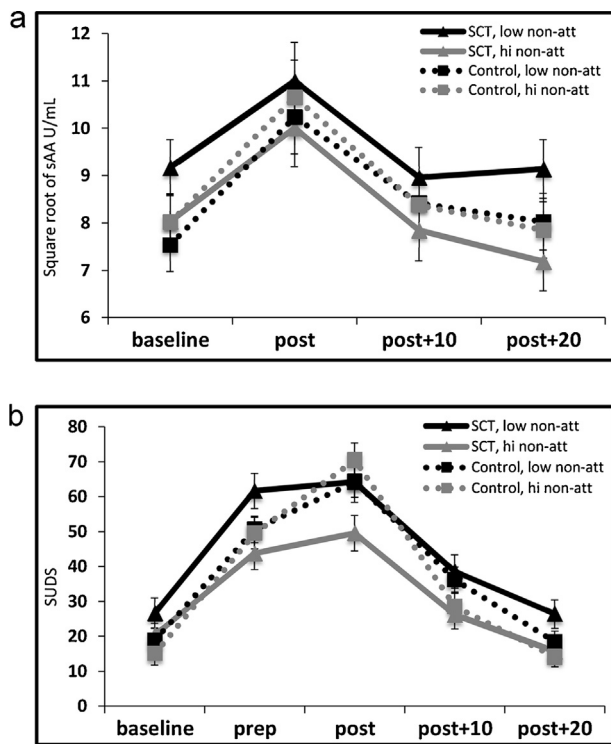
[**] indicates $p \leq .05$ for the sAA outcome.

Fig. 1. (a) Moderation of salivary alpha-amylase response to the TSST by a non-attachment × condition × time² interaction (±1SE; $p = 0.02$). Non-attachment predicted sAA responses to a greater extent in the SCT than control groups, such that those higher in non-attachment in the SCT group showed the lowest sAA reactivity and fastest recovery, whereas those lower in non-attachment in the SCT condition showed higher overall sAA levels. (b) Moderation of subjective anxiety (SUDS) response to the TSST by a non-attachment x condition × time² interaction (±1SE; $p = 0.04$). Non-attachment played a greater role in the SCT than control groups; those scoring higher in non-attachment showed lower levels of SUDS reactivity relative to those lower in non-attachment in SCT. In contrast, both more and less attached control participants showed a similar level and arc of SUDS response to the TSST.
Note: SCT = Self-Compassion Training; non-att = trait non-attachment; sAA = salivary alpha amylase; SUDS = Subjective Units of Distress Scale; TSST = Trier Social Stress Task.

of trait self-compassion across condition that did not differ significantly by assessment point.

The *non-attachment* × Group 2 × quadratic time interaction was significant in predicting sAA, $b = -0.01$, $p = 0.02$, indicating that non-attachment moderated the intervention condition effect on sAA in a curvilinear manner over time. Fig. 1a shows that non-attachment levels predicted sAA responses more in the SCT than control groups, reflecting a pattern such that those higher in non-attachment (less attached) in the SCT condition showed the lowest sAA reactivity and fastest sAA recovery among the participants, whereas those lower in non-attachment (more attached) in the SCT condition showed higher overall sAA levels throughout. In contrast, non-attachment levels did not influence response in the control conditions to the same extent as in the SCT (e.g., both more and less attached control participants showed a similar level of sAA and arc of sAA reactivity and recovery). The same non-attachment × Group 2 × quadratic time interaction significantly predicted SUDS, $b = 0.04$, $p = 0.04$, with a similar pattern of intervention condition by trait differences. As illustrated in Fig. 1b, levels of non-attachment played a greater role among SCT trainees, such that those higher in non-attachment (less attached) showed the lowest levels of SUDS reactivity among participants whereas those lower in non-attachment (more attached) showed higher levels of SUDS throughout. In contrast, both more and less attached control group participants showed a similar level and arc of TSST response.
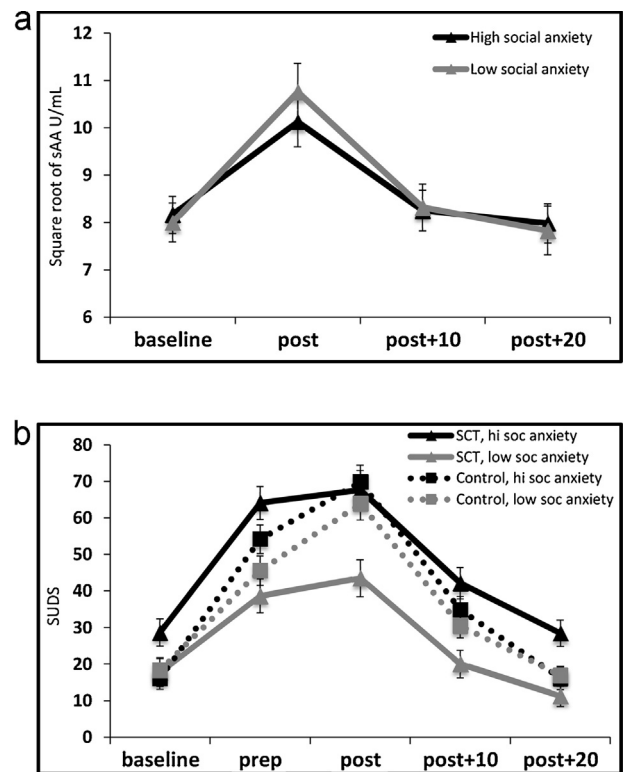

Fig. 2. (a) Prediction of salivary alpha-amylase response to the TSST by a social anxiety by time² interaction (±1SE; $p = 0.04$). Higher levels of social anxiety predicted a different arc of sAA responses, driven by lower sAA immediately following the TSST. b Moderation of subjective anxiety (SUDS) response to the TSST by a social anxiety by condition interaction (±1SE; $p = 0.04$). Social anxiety levels predicted SUDS levels to a greater extent in the SCT condition than in the control conditions.
Note: SCT = Self-Compassion Training; non-att = trait non-attachment; sAA = salivary alpha amylase; SUDS = Subjective Units of Distress Scale; TSST = Trier Social Stress Task.

Social anxiety did not moderate the impact of SCT on the cascade of sAA responses to the TSST; that is, the interaction of social anxiety × Group 2 × quadratic time was non-significant, $b = 0.00$, $p = 0.99$. However, examining social anxiety as a *predictor* of sAA across conditions revealed an interaction of social anxiety with quadratic time, $b = 0.06$, $p = 0.04$, such that higher levels of social anxiety predicted lower sAA responses at immediate post-TSST, as illustrated in Fig. 2a. For SUDS responses to the TSST, the interaction of social anxiety × Group 2 × quadratic time also was non-significant, $b = -0.11$, $p = 0.42$. However, there was an overall social anxiety × Group 2 interaction (on the intercept term, see Table 1 and Fig. 2b), $b = 1.48$, $p = 0.04$, with the pattern showing that social anxiety influenced overall SUDS levels to a greater extent in the SCT condition than in the control conditions. Thus, SCT participants with lower social anxiety levels showed the lowest levels of SUDS reactivity to the TSST whereas SCT participants with higher social anxiety levels showed higher SUDS throughout (though a pattern of lower increase from baseline to *peak* SUDS, compared to the control conditions).

Rumination moderated the effect of intervention condition on curvilinear change in sAA in response to the TSST, that is, the rumination × Group 2 × quadratic time interaction was significant, $b = 0.01$, $p = 0.01$. Fig. 3 shows that those lower in rumination demonstrated lower sAA during recovery from the TSST (relative to those higher in rumination) and that this effect was more pronounced in the control conditions at 10 min recovery (reflecting a pattern of slower initial recovery among high rumination controls relative to low rumination controls). Although those higher and lower in rumination within the SCT condition diverged at
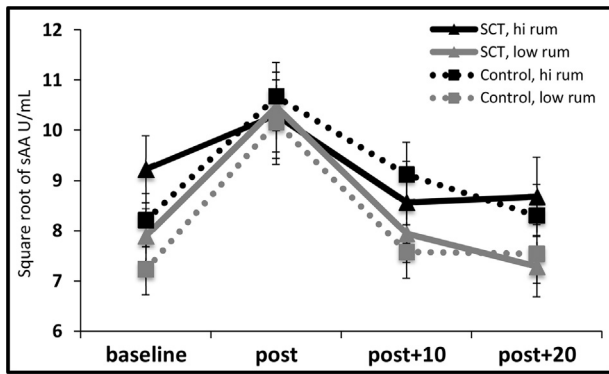
Fig. 3. Moderation of salivary alpha amylase response to the TSST by a rumination × condition × time^2 interaction ($\pm$1SE; $p = 0.01$). Those lower in rumination had lower sAA during TSST recovery compared to those higher in rumination; this effect was more pronounced in the control condition (reflecting slower post-TSST recovery among high rumination relative to low rumination control participants).
Note: SCT = Self-Compassion Training; rum = trait rumination; sAA = salivary alpha amylase.

20 min (final) recovery, this appears to reflect the fact that the higher rumination SCT group showed higher baseline levels of sAA (but not slower recovery to baseline). Rumination neither moderated the intervention effect nor predicted curvilinear change in SUDS responses to the TSST, $ps > 0.56$. Rather, higher rumination predicted higher SUDS throughout the session, without respect to assessment point or condition; that is, the main effect of rumination on the intercept was significant, $b = 0.52$, $p = 0.005$.

4. Discussion

This is one of the few studies to examine baseline psychological trait moderators of the effect of resiliency training on TSST responses and the first to examine moderators of self-compassion training in this context. Additionally, it only the second known study (c.f., Maruyama et al., 2012) to explore (cross-condition) trait prediction of sAA response to the TSST. The findings largely confirmed our hypotheses that baseline traits would moderate training effects on sympathetic (sAA) and subjective anxiety (SUDS) responses to the TSST.

The influence of several psychological traits on sAA and subjective anxiety responses to the TSST were more pronounced following self-compassion training than following the control conditions. Specifically, non-attachment, a resiliency trait, influenced sAA and subjective anxiety responses to the TSST more in the SCT than the control conditions, such that those who received SCT and were higher in non-attachment (less attached) showed the most resilient response profiles of all participants, with a pattern of lower sAA and subjective anxiety responses to the TSST (either at immediate post-TSST or during recovery). Similarly, social anxiety levels influenced subjective anxiety responses to the TSST more in the SCT than control conditions, such that those who received SCT and were lower in social anxiety showed the lowest subjective reactivity to the TSST, relative to the higher subjective anxiety responses reported by those in SCT who were higher in social anxiety. In contrast, control participants who were high or low in non-attachment or social anxiety (the latter, for subjective anxiety responses only) did not differ as much on their responses to the TSST. This suggests that lower attachment and social anxiety levels potentiated the effects of SCT such that those who expressed more optimal levels of these traits at baseline (higher non-attachment and lower social anxiety) benefitted more from SCT than those with less optimal levels of these traits. Thus, thus, not everyone benefitted from SCT similarly. In light of the brief nature of SCT offered in the cur-

rent study, participants with less optimal levels of these traits may require more intensive or tailored self-compassion training in order to realize similar benefits as those with more optimal levels.

In contrast, the influence of rumination on sAA responses was somewhat more pronounced in the control conditions than the SCT condition. Thus, participants higher versus lower on rumination in the control conditions diverged more during early recovery than those in the SCT; in contrast, participants higher in rumination in the SCT condition showed higher baseline sAA levels but a pattern of lower peak (from baseline) and faster recovery to baseline following the TSST, relative to those higher in rumination within the control conditions. Thus, compared to the control conditions, SCT appears to have particularly benefitted those higher in rumination from the perspective of facilitating a faster return to baseline, albeit a high baseline.

Social anxiety and rumination have known impacts on post-event processing and recovery from stressful social events (Condren et al., 2002; Young and Nolen-Hoeksema, 2001), and this study suggests that these traits influence the effects of self-compassion training. Conversely, non-attachment, a novel construct in psychobiological science, benefited SCT outcomes, findings that support further study of this trait in resiliency research. Notably, these trait moderations of sAA and anxiety were not statistically large, suggesting that SCT had relatively robust effects on these outcomes (see Ref. Arch et al., 2014) even after accounting for SCT-relevant resilience and vulnerability traits.

Interestingly, while higher trait self-compassion predicted lower SUDS anxiety, but not sAA, across time, it did not amplify (moderate) the effects of SCT. This is not consistent with the amplification of mindfulness training on social stress responses afforded by trait mindfulness (Creswell et al., 2014), and suggests that SCT is appropriate even for individuals without the dispositional predilection towards it. Further, the relationship of social anxiety levels and sAA responses were inconsistent with other findings, in that higher social anxiety levels (across groups) predicted lower sAA increases in immediate response to the TSST. Thus, further investigation is needed to assess the contexts under which lower sAA responses to the TSST reflect more or less optimal levels of a trait.

5. Conclusion

The present findings represent one of the few investigations that address for whom resilience enhancement interventions buffer psychological and sympathetic social stress responses. Most examined traits interacted with condition to predict subjective or sAA responses to the TSST. Thus, findings indicated potential boundary conditions for brief SCT among young women, such those higher in social anxiety or attachment benefitted less than those with lower levels of these traits; yet women with higher or lower levels of trait self-compassion benefitted similarly. These findings support further study of the important question of for whom resiliency training in general, and self-compassion training in particular, benefits most.

Conflicts of interest

None.

Contributors

All authors helped to conceptualize the study, J. J. A. and L. N. L. conducted the data analyses, L.N.L. drafted the original paper with input from J. J. A. and K. W. B., and J. J. A. extensively revised the paper with input from L. N. L. and K. W. B. All authors approved the final version.

Funding

None. That is, the funding source did not have any role in designing, analyzing, writing, or making any decisions about this article.

Acknowledgements

References

Arch, J.J., Brown, K.W., Dean, D.J., Landy, L.N., Brown, K.D., Laudenslager, M.L., 2014. Self-compassion training modulates alpha-amylase, heart rate variability: and subjective responses to social evaluative threat in women. Psychoneuroendocrinology 42, 49–58.

Brown, K.W., Weinstein, N., Creswell, J.D., 2012. Trait mindfulness modulates neuroendocrine and affective responses to social evaluative threat. Psychoneuroendocrinology 37, 2037–2041.

Chida, Y., Hamer, M., 2008. Chronic psychosocial factors and acute physiological responses to laboratory-induced stress in healthy populations: a quantitative review of 30 years of investigations. Psychol. Bull. 134 (6), 829.

Condren, R.M., O'Neill, A., Ryan, M.C.M., Barrett, P., Thakore, J.H., 2002. HPA axis response to a psychological stressor in generalised social phobia. Psychoneuroendocrinology 27 (6), 693–703.

Creswell, J.D., Pacilio, L.E., Lindsay, E.K., Brown, K.W., 2014. Brief mindfulness meditation training alters psychological and neuroendocrine responses to social evaluative stress. Psychoneuroendocrinology 44, 1–12.

Creswell, J.D., Welch, W.T., Taylor, S.E., Sherman, D.K., Gruenewald, T.L., Mann, T., 2005. Affirmation of personal values buffers neuroendocrine and psychological stress responses. Psychol. Sci. 16 (11), 846–851.

Dickerson, S.S., Gruenewald, T.L., Kemeny, M.E., 2004. When the social self is threatened: shame, physiology, and health. J. Pers. 72 (6), 1191–1216.

Gilbert, P., McEwan, K., Matos, M., Rivis, A., 2011. Fears of compassion: development of three self-report measures. Psychol. Psychother. Theory Res. Pract. 84 (3), 239–255.

Gilbert, P., Procter, S., 2006. Compassionate mind training for people with high shame and self-criticism: overview and pilot study of a group therapy approach. Clin. Psychol. Psychother. 13 (6), 353–379.

Hammerfald, K., Eberle, C., Grau, M., Kinsperger, A., Zimmermann, A., Ehlert, U., Gaab, J., 2006. Persistent effects of cognitive-behavioral stress management on cortisol responses to acute stress in healthy subjects—a randomized controlled trial. Psychoneuroendocrinology 31 (3), 333–339.

Kirschbaum, C., Pirke, K.M., Hellhammer, D.H., 2008. The trier social stress test–a tool for investigating psychobiological stress responses in a laboratory setting. Neuropsychobiology 28.

Leary, M.R., Tate, E.B., Adams, C.E., Batts Allen, A., Hancock, J., 2007. Self-compassion and reactions to unpleasant self-relevant events: the implications of treating oneself kindly. J. Pers. Soc. Psychol. 92 (5), 887.

Maruyama, Y., Kawano, A., Okamoto, S., Ando, T., Ishitobi, Y., Tanaka, Y., Akiyoshi, J., 2012. Differences in salivary alpha-amylase and cortisol responsiveness following exposure to electrical stimulation versus the Trier Social Stress Tests. PLoS One 7 (7), e39375.

Mattick, R.P., Clarke, J.C., 1998. Development and validation of measures of social phobia scrutiny fear and social interaction anxiety1. Behav. Res. Ther. 36 (4), 455–470.

Nater, U.M., La Marca, R., Florin, L., Moses, A., Langhans, W., Koller, M.M., Ehlert, U., 2006. Stress-induced changes in human salivary alpha-amylase activity—associations with adrenergic activity. Psychoneuroendocrinology 31 (1), 49–58.

Nater, U.M., Rohleder, N., 2009. Salivary alpha-amylase as a non-invasive biomarker for the sympathetic nervous system: current state of research. Psychoneuroendocrinology 34 (4), 486–496.

Nater, U.M., Rohleder, N., Gaab, J., Berger, S., Jud, A., Kirschbaum, C., Ehlert, U., 2005. Human salivary alpha-amylase reactivity in a psychosocial stress paradigm. Int. J. Psychophysiol. 55 (3), 333–342, http://dx.doi.org/10.1016/j.ijpsycho.2004.09.009.

Neff, K.D., 2003. The development and validation of a scale to measure self-compassion. Self and identity 2 (3), 223–250.

Neff, K.D., Germer, C.K., 2013. A pilot study and randomized controlled trial of the mindful self-compassion program. J. Clin. Psychol. 69 (1), 28–44.

Norcross, J.C., Wampold, B.E., 2011. What works for whom: tailoring psychotherapy to the Person. J. Clin. Psychol. 67 (2), 127–132.

Pace, T.W., Negi, L.T., Adame, D.D., Cole, S.P., Sivilli, T.I., Brown, T.D., Raison, C.L., 2009. Effect of compassion meditation on neuroendocrine, innate immune and behavioral responses to psychosocial stress. Psychoneuroendocrinology 34 (1), 87–98.

Rohleder, N., Nater, U.M., Wolf, J.M., Ehlert, U., Kirschbaum, C., 2004. Psychosocial stress-induced activation of salivary alpha-amylase: an indicator of sympathetic activity? Ann. N. Y. Acad. Sci. 1032 (1), 258–263.

Sahdra, B.K., Shaver, P.R., Brown, K.W., 2010. A scale to measure non-attachment: a Buddhist complement to Western research on attachment and adaptive functioning. J. Pers. Assess. 92 (2), 116–127.

Trapnell, P.D., Campbell, J.D., 1999. Private self-consciousness and the five-factor model of personality: distinguishing rumination from reflection. J. Pers. Soc. Psychol. 76, 284–304.

Wolpe, J., 1990. The Practice of Behavior Therapy, 4th ed. Pergamon Press, New York.

Young, E.A., Nolen-Hoeksema, S., 2001. Effect of ruminations on the saliva cortisol response to a social stressor. Psychoneuroendocrinology 26 (3), 319–329.