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ORIGINAL PAPER

Compassion Meditation for Veterans with PTSD: Home Practice Matters

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Abstract

Objectives There is strong rationale and growing empirical support for compassion meditation as an alternative treatment for PTSD. The purpose of this study was to examine the importance of home meditation practice, a central component of compassion meditation approaches, among veterans with PTSD participating in an adapted version of Cognitively-Based Compassion Training (CBCT®).

Methods Participants were 49 veterans with PTSD as determined by clinical interview with a mean age of 46.2 (SD = 14.5) pooled from three studies (non-randomized pilot study, randomized proof-of-concept study, telehealth-delivered feasibility study). During the CBCT intervention, participants completed weekly clinical outcome assessments of PTSD symptoms, depression symptoms, negative affect, and positive affect. Participants also completed a weekly practice log, including the duration of home meditation practice over the previous week. Linear mixed-effects models were used to evaluate the relationship between weekly home meditation practice and weekly change in clinical outcomes.

Results Home meditation practice was associated with significant improvement in depression symptoms ($B = -0.03$, SE = 0.01, $p < 0.001$), negative affect ($B = -0.04$, SE = 0.01, $p = 0.007$), and positive affect ($B = 0.03$, SE = 0.01, $p = 0.005$) controlling for treatment session.

Conclusions These findings underscore the importance of home meditation practice among veterans with PTSD learning compassion meditation. This preliminary evaluation should be replicated and additional research is needed to identify optimal home practice dosing to maximize adherence while achieving clinically meaningful improvement.

Trial Registration ClinicalTrials.gov Identifier: NCT02372396.

Keywords Compassion · Adherence · Depression · Positive affect · Negative affect

Posttraumatic stress disorder (PTSD) is a highly prevalent and disabling condition that affects between 10.1 and 30.9% of military veterans (Eber et al., 2013; Gradus, 2007). Though those affected may have access to evidence-based PTSD interventions, including prolonged exposure (PE) and cognitive processing therapy (CPT), only a small percentage complete all scheduled sessions and many drop out before receiving an adequate dose of treatment (Najavits, 2015; Watts et al., 2014). Among veterans who complete CPT or PE, about a third do not achieve clinically meaningful improvement in PTSD symptomology (Rutt et al., 2018). Thus, veterans would greatly benefit from complementary or alternative interventions for the treatment of PTSD and are indeed interested in such interventions including complementary and integrative health (CIH) approaches. Among a sample of 1230 veterans receiving healthcare at the Veterans Health Administration, 84% indicated interest in trying/learning more about CIH interventions (Taylor et al., 2019).

There is strong theoretical rationale and growing empirical support for compassion meditation (CM) for PTSD. CM approaches aim to cultivate a genuine urge to alleviate suffering in others and the self (Hofmann et al., 2011). In

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addition to increased self-compassion and compassion for others (Jazaieri et al., 2013; LoParo et al., 2018), CM-based interventions have been associated with decreased subjective and physiological responses to stress (Pace et al., 2009), enhanced positive affect (Klimecki et al., 2013), reduced anger (Chapin et al, 2014), and increased prosocial behavior (Weng et al., 2013). Given that individuals with PTSD often experience high levels of negative affect, low levels of positive affect, and poor social and interpersonal functioning that interact with and exacerbate PTSD severity (DePierro et al., 2018; Schnurr et al., 2009; Vujanovic et al., 2013), CM approaches may be particularly indicated for this population.

There are several CM interventions that have been examined in the literature, including compassion cultivation training, compassion-focused therapy (CFT), mindful self-compassion (MSC), and Cognitively-Based Compassion Training (CBCT®) (Kirby, 2017; Shonin et al., 2015). While these interventions share similarities and differences worth considering, a detailed review is beyond the scope of this manuscript. CBCT was previously adapted for use with veterans (CBCT-Vet) (Lang et al., 2020) and evaluated for its impact on PTSD and related symptoms (Lang et al., 2019). Briefly, the goals of CBCT-Vet are to provide psychoeducation on CM for PTSD; to train veterans in focused attention meditation, present moment awareness meditation, and analytical meditations focused on compassion for self and others; and to integrate CBCT principles and practices into daily living (for a more detailed overview of CBCT, see Lang et al., 2020). Compared to a relaxation control group, CBCT-Vet was associated with significantly greater reductions in PTSD severity, as well as medium to large within-group effect size improvements (Cohen's *d*'s: 0.45 s–1.09) in depression, negative affect, positive affect, social connectedness, mindful awareness, empathy, and rumination (Lang et al., 2019).

Studies have examined other CM and related approaches for PTSD and similarly found promising results. This includes a non-randomized pilot study of CFT for veterans with PTSD and anger, which demonstrated improvements in anger symptoms, PTSD symptoms, and fears of compassion (Grodin et al., 2019). Kearney et al. (2021) compared loving-kindness meditation (LKM) to CPT in a randomized non-inferiority trial among veterans with PTSD. Modest improvements in PTSD symptomology were found in both conditions without meaningful differences between groups, while veterans receiving LKM demonstrated significantly greater reductions in depressive symptomology compared to CPT. It is important to note that LKM is related but distinct from CM. LKM consists of the repetition of positive mantra-like phrases, known as metta, to specified persons that the practitioner chooses including oneself. CM on the other hand is the practice of karuna, which is the cultivation of awareness of the suffering of self and others as well as the wish to relieve that suffering (Buddhaghosa, 1975; Hofmann et al., 2011).

A central component of CBCT and meditative-based approaches in general is home meditation practice. CBCT incorporates a sequential practice regimen that includes focused attention, present moment awareness, self-compassion, and other-oriented compassion practices (Ash et al., 2019). Participants are expected to adhere to daily practice throughout the course of CBCT to help produce a fundamental shift in how the self and others are viewed and derive maximum benefit from the intervention. There is a small but growing literature on the importance of home meditation adherence in CBCT. Among a small sample of breast cancer survivors that completed CBCT, total meditation practice time was associated with reduced fear of cancer recurrence (Dodds et al., 2015). Among adolescents within foster care, total meditation practice time was negatively associated with salivary C-reactive protein concentrations (Pace et al., 2009), an inflammatory biomarker linked to several chronic diseases (Ansar & Ghosh, 2013), and practice frequency was related to increased hopefulness and decreased anxiety (Reddy et al., 2013). Other studies of CBCT have found no relationship between home meditation practice and outcomes (Desbordes et al., 2012; Mascaro et al., 2018).

The purpose of this study was to examine the association between home meditation practice and change in PTSD severity, depression symptoms, and positive and negative affect among veterans with PTSD participating in CBCT. This study utilized data from two completed trials (Lang et al., 2019, 2020), as well as data presented at a conference but not published (Baca et al., 2018), to represent all veterans who have received CBCT-Vet for PTSD to date. We hypothesized that greater adherence to weekly home practice would be associated with greater improvement in PTSD severity, depression symptoms, positive affect, and negative affect.

Methods

Participants

Participants consisted of 60 US military veterans who were able and willing to consent to study procedures. Inclusion criteria were intentionally as broad as possible, with comorbid diagnoses including depression, anxiety, or substance use disorders being generally permitted as long as PTSD was the primary presenting complaint. The Mini International Neuropsychiatric Interview 6.0 was used to verify current PTSD diagnosis, as well as to help determine exclusion criteria (Sheehan et al., 1998). Exclusion criteria included high risk of suicide/homicide, untreated substance use disorder or serious mental illness (e.g., psychotic disorder, bipolar

I), cognitive impairment, and concurrent PTSD treatment. Additional exclusion criteria for the present study were missing data on clinical outcome assessments ($n = 3$) and available data on meditation practice ($n = 8$), which resulted in a final sample size of 49. Among excluded participants without meditation practice data, four withdrew after the first session, two completed two sessions, one completed six sessions, and one completed seven sessions. There were no sociodemographic differences between included and excluded participants. However, the eight excluded participants without meditation practice data reported higher ratings of negative affect, depression symptoms, and PTSD symptoms at baseline compared to included participants (p's < 0.01).

Participant demographics are reported in Table 1. Participants were primarily male (81.6%) with an average age of 46.2 (SD = 14.5). Regarding race, 27 (55.1%) identified as white, six as black/African American (12.2%), nine as more than one race (18.4%), and seven as other. A third of the sample identified as Hispanic/Latino ($n = 16$, 32.7%). Average education was 14.4 years (SD = 2.3) and about half were married ($n = 21$, 42.9%).

Table 1 Participant baseline characteristics ($N = 49$)

Demographic characteristics	
Age (years)	46.18 (14.47)
Gender (female, %)	9 (18.4%)
Race	
Black/African American	6 (12.2%)
Other*	7 (14.3%)
> 1 Race	9 (18.4%)
White	27 (55.1%)
Ethnicity (Hispanic/Latino)	16 (32.7%)
Education (years)	14.44 (2.28)
Marital status	
Never married	9 (18.4%)
Married/common law/living with partner	21 (42.9%)
Divorced/separated/widowed	19 (38.8%)
Service branch	
Air Force	3 (6.1%)
Army	12 (24.5%)
Marines	17 (34.7%)
Navy	11 (22.4%)
Two branches or more	6 (12.2%)
Study Phase	
Phase 1	25 (51.0%)
Phase 2	13 (26.5%)
Phase 3	11 (22.4%)
Comorbid conditions**	
Major depressive episode	26 (53.1%)
Panic disorder	14 (28.6%)
Agoraphobia	22 (44.9%)
Social phobia	20 (40.8%)
Generalized anxiety disorder	6 (12.2%)
Clinical characteristics	
PCL-5	43.97 (16.61)
PHQ-9	13.84 (5.62)
mDES-neg	17.94 (9.55)
mDES-pos	16.49 (7.68)

Note: Data is count (%) or mean (SD). *PCL-5*, PTSD Checklist for DSM-5; *PHQ-9*, Patient Health Questionnaire-9; *mDES-neg/pos*, modified Differential Emotions Scale negative/positive. *Includes one participant that did not report race. **Determined by the Mini International Neuropsychiatric Interview at screening

Procedure

Participants were recruited via clinician referral and self-referral from brochures and advertisements. During the initial study visit, potential participants provided informed consent and HIPAA authorization before providing demographic information and completing eligibility screening. Eligible participants then completed several clinician-administered interviews, self-report questionnaires, and weekly symptom checklists. Participants also completed self-report questionnaires of credibility after the first session and treatment satisfaction after the final session. Assessments (other than eligibility screening measures) were repeated after completing treatment. Study procedures are described in greater detail elsewhere (Lang et al., 2019, 2020).

Of the 49 participants, 25 participated in a non-randomized pilot study of CBCT-Vet (phase 1; Lang et al., 2020), 13 as part of a randomized proof-of-concept study comparing CBCT-Vet to a matched relaxation control group (phase 2; Lang et al., 2019), and 11 as part of a feasibility study of telehealth-delivered CBCT-Vet (phase 3; Baca et al., 2018). Procedures across studies were generally consistent among this combined dataset with two exceptions: (1) session length/number of sessions differed; $n = 20$ participated in 8 weekly, 120-min sessions and $n = 29$ (including five phase 1 participants, as well as all phase 2 and 3 participants) participated in 10 weekly, 90-min sessions (session length changed based on feedback during phase 1), and (2) 11 participants engaged in the protocol from a remote location via telehealth. All CBCT-Vet sessions were facilitated by a licensed clinical psychologist and certified CBCT instructor (PC) in a VA outpatient mental health clinic. During the course of CBCT-Vet, participants were assigned specific home meditation practices and provided audio recordings to guide and facilitate practice.

Measures

Participants completed a battery of eligibility measures, clinical interviews, and self-report questionnaires described

elsewhere. Here, we briefly describe measures related to aims and hypotheses of these secondary analyses.

Weekly evaluation of clinical outcomes included measures of PTSD (PTSD Checklist for DSM-5, PCL-5; Weathers et al., 2013) and depression (Patient Health Questionnaire, PHQ-9; Kroenke et al., 2001). The PCL-5 is a 20-item self-report measure commonly used to monitor changes in PTSD symptom severity. Items are rated on a scale of 0 to 4, with total scores ranging from 0 to 80 (higher score indicates greater symptom severity). The PHQ-9 is likewise a reliable and valid measure of depression symptom severity with 9 items rated from 0 to 3 (total scores range from 0 to 27 with higher score indicating greater symptom severity). Participants also completed weekly measures of positive and negative emotions (modified Differential Emotions Scale, mDES; Fredrickson et al., 2003). The mDES consists of self-reported ratings (0 to 4) of 10 positive (e.g., joy, gratefulness) and 10 negative (e.g., anger, guilt) emotions, yielding two scores (positive affect and negative affect) ranging from 0 to 40.

Meditation Journal Each week, participants were asked to complete a daily home meditation practice journal. Assigned types of meditation with provided guided audio were as follows: sessions 1 and 2—attentional breathing; sessions 3 and 4—present moment awareness; session 5—self-compassion; session 6—impartiality and inclusivity; session 7—gratitude; session 8—engaged compassion; session 9—overview of meditation practices. For the 8-session protocol, length of assigned meditation practices increased from 6 min/day at session 1 (42 min/week), 12 min/day for sessions 2–4 (84 min/week), to 15 min/day for sessions 5–7 (105 min/week). The schedule was similar for the 10-session protocol, except that 15/min per day was assigned at session 4 as opposed to 12/min per day, as well as 15 min/day assigned for sessions 8 and 9. No meditation practice was assigned at the final session. Though these were the assigned times, participants were encouraged to complete additional home meditation practice. Participants indicated whether they completed daily practice (Y/N) and recorded total time spent in meditation each day. The weekly time spent in meditation practice for each week was calculated for the analysis.

Data Analyses

Participant characteristics were summarized by descriptive statistics. Pearson's correlation coefficients were used to examine the association between outcome measures at baseline. The outcomes of interest were the change in PTSD symptoms, depression symptoms, negative affect, and positive affect. Here, change refers to the difference between weekly outcomes over the course of the intervention relative to the first treatment session (i.e., session 2 minus session 1, session 3 minus session 1, etc.). These outcomes and the weekly meditation practice time were summarized by study session. Linear mixed-effects (LME) models were used to examine the relationship between weekly meditation practice and change in PTSD symptoms, depression symptoms, negative affect, and positive affect in the corresponding week. Models were built hierarchically by first including treatment session as a continuous variable to examine the association between the change in outcome and treatment session followed by adding home meditation practice as a time-varying predictor. Both random slope for treatment session and random intercept were considered, and models were compared using the likelihood ratio test (LRT) as well as Akaike Information Criteria (AIC). If the p-value for LRT was < 0.05, the model with a larger likelihood and a smaller AIC was selected. LME modeling was chosen because it is a superior method for analyzing longitudinal data by taking into account the correlation of repeated measures within each individual as well as using all available data (Gueorguieva & Krystal, 2004), which allowed us to include participants that completed both the 8- and 10-session protocols in the same analysis. Participant characteristics and study phase were also considered potential covariates in the multivariable analysis. The associations between each participant characteristics and the outcome variables as well as home mediation practice were examined first using LME. Only variables associated with the outcome or home meditation practice time at $p < 0.10$ were considered covariates in the multivariable model. We chose this criterion to ensure variables marginally and significantly associated with the outcome or practice were accounted for in final models. A backward variable elimination was performed to only keep covariates that were significant at $p < 0.10$. Sensitivity analyses were performed by excluding the five participants that completed the 10-session protocol during phase 1. All statistical analyses were performed using R.

Results

Table 2 shows correlations among outcome variables at baseline. Significant correlations were observed among baseline PTSD symptoms, depression symptoms, and negative affect ($p < 0.001$), while baseline positive affect was not significantly related to other outcome variables. During data preparation, one highly unusual case of home meditation practice was detected during the second week of the intervention (weekly practice = 578 min, or 82.6 min/day) and excluded from subsequent analyses. Consistent with the protocol, weekly home meditation practice significantly increased over time across participants ($B = 5.79$, SE = 0.93, $p < 0.001$). Specifically, mean weekly home meditation (min) was as follows: session 2 = 42.4; session 3 = 79.5;

Table 2 Pearson correlations among outcome variables at baseline

	1	2	3
1. PCL-5			
2. PHQ-9	0.76**		
3. mDES-neg	0.71**	0.63**	
4. mDES-pos	−0.14	−0.26	−0.26

Note: *PCL-5*, PTSD Checklist for DSM-5; *PHQ-9*, Patient Health Questionnaire-9; *mDES-neg/pos*, modified Differential Emotions Scale negative/positive. **$p < 0.001$

Table 3 Linear mixed-effects models showing the association among treatment session and weekly practice adherence with treatment outcomes among veterans with PTSD participating in CBCT

	Estimate	SE	95% CI	*p*-value
Outcome: PTSD symptoms				
Treatment session	−0.80	0.34	−1.49, −0.11	0.023
Home practice	−0.04	0.02	−0.07, 0.003	0.07
Outcome: depression symptoms				
Treatment session	−0.15	0.14	−0.42, 0.12	0.28
Home practice	−0.03	0.01	−0.04, −0.01	< 0.001
Outcome: negative affect				
Treatment session	−0.30	0.23	−0.76, 0.16	0.20
Home practice	−0.04	0.01	−0.07, −0.01	0.007
Outcome: positive affect				
Treatment session	0.34	0.16	0.01, 0.66	0.04
Home practice	0.03	0.01	0.01, 0.06	0.005

session 4 = 84.6; session 5 = 93.4; session 6 = 97.9; session 7 = 94.1; session 8 = 99.8; session 9 = 106.6; and session 10 = 106.3. No adverse events (e.g., increased alcohol/substance use, anxiety, depression, discomfort, dissociation, suicidality, homicidally) related to home meditation practice were reported during treatment sessions.

Linear mixed-effects models with both random slope and random intercept used to examine change across treatment sessions demonstrated significant improvements in PTSD symptoms ($B = -1.01$, SE = 0.33, $p = 0.003$), depression symptoms ($B = -0.31$, SE = 0.13, $p = 0.02$), positive affect ($B = 0.52$, SE = 0.16, $p = 0.001$), and negative affect ($B = -0.55$, SE = 0.22, $p = 0.013$). We then examined models that included both treatment session and weekly home meditation practice as predictors (see Table 3). Treatment session remained a significant predictor of change in PTSD symptoms ($B = -0.80$, SE = 0.34, $p = 0.023$) and positive affect ($B = 0.34$, SE = 0.16, $p = 0.04$), but not depression symptoms ($B = -0.15$, SE = 0.14, $p = 0.28$) or negative affect ($B = -0.30$, SE = 0.23, $p = 0.20$). More weekly home meditation practice was significantly associated with greater reductions in depression symptoms ($B = -0.03$, SE = 0.01, $p < 0.001$) and negative affect ($B = -0.04$, SE = 0.01, $p = 0.007$), and greater improvement in positive affect ($B = 0.03$, SE = 0.01, $p = 0.005$), but was marginally associated with change in PTSD symptoms ($B = -0.04$, SE = 0.02, $p = 0.07$). Figure 1 shows a graphical depiction of change in outcomes together with weekly meditation practice time. In the adjusted analyses, we only found study phase and service branch were significantly associated with negative affect change. The association between meditation practice and negative affect remained similar after accounting for these variables ($B = -0.04$, SE = 0.01, $p = 0.01$). Results were unchanged in the sensitivity analyses that excluded the five participants from phase 1 that received the 10-session protocol. We also performed the same analyses but with weekly home practice frequency (i.e., number of days per week practiced) and found similar results.

Discussion

The purpose of the present study was to examine the association between home meditation practice and change in clinical outcomes among veterans with PTSD participating in CM. More time spent in home meditation practice was related to greater reductions in depression symptoms and negative affect, and greater improvements in positive affect. These findings suggest adherence to home practice may be an important component for optimizing the benefits of CM-based interventions among individuals with PTSD.

Negative affect is a core feature of PTSD and helps explain the high comorbidity between PTSD and major depressive disorder (Byllesby et al., 2016; Post et al., 2011). In this study, high correlations were found at baseline among PTSD symptoms, depression symptoms, and negative affect, underscoring the strong association among these variables. Interestingly, we found a non-significant main effect of treatment session on negative affect, yet home meditation practice was associated with significant change in negative affect. This suggests that the home meditation practices within CBCT-Vet may be specifically targeting negative affect more so than the in-person session components. In other words, repetitive practice may be more important than didactics to induce a shift in negative affect. This is consistent with past research showing the habitual use of self-compassion strategies was uniquely associated with reductions in negative emotions (Arimitsu & Hofmann, 2017; Leary et al., 2007). This may also help explain why meditation practice was more strongly associated with reductions in depression symptoms compared to PTSD symptoms, which did not reach statistical significance.

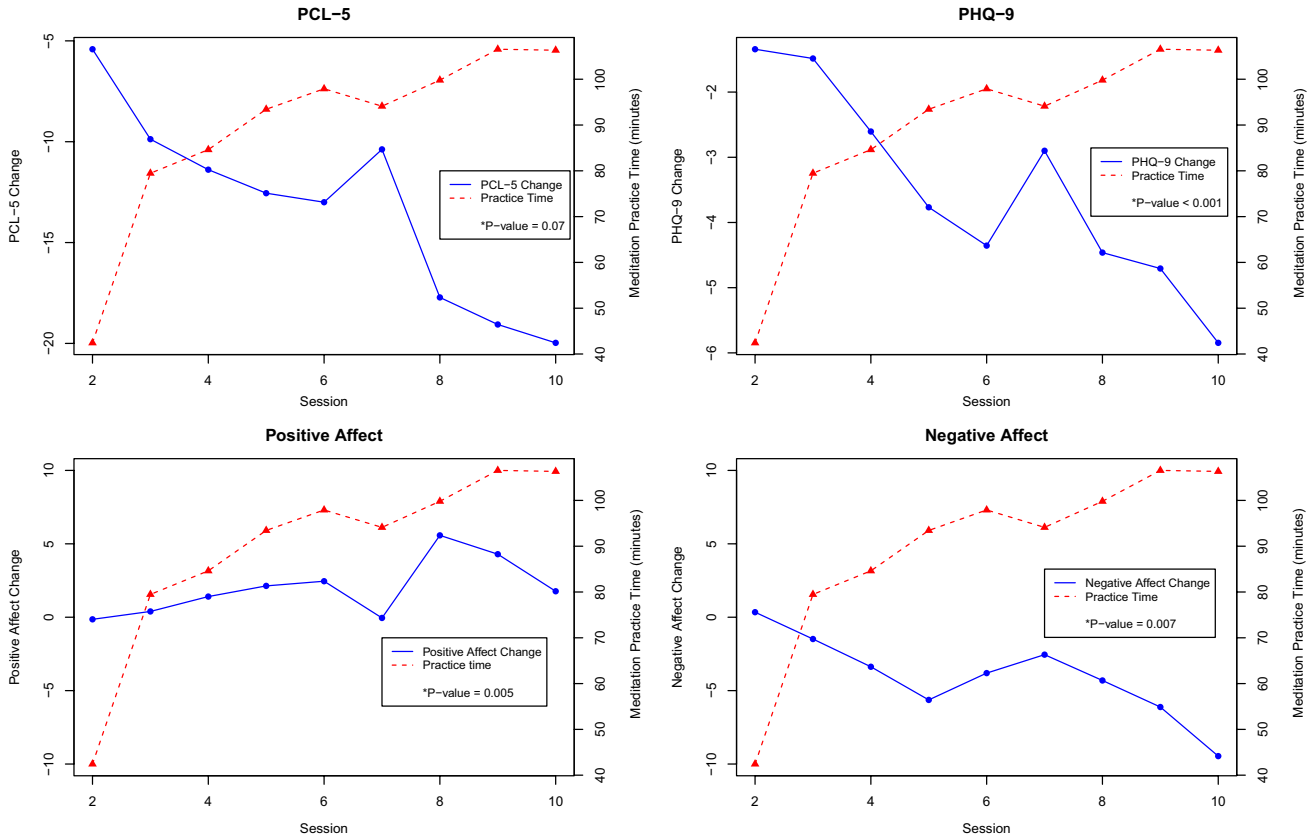


Fig. 1 Group mean levels of weekly home meditation practice time plotted against change in outcome measures. Note: *p*-values denote the association between weekly home meditation practice time and change in outcome measures controlling for treatment session

Despite the high prevalence of low positive affect in PTSD and its association with impaired functioning, most evidence-based treatments for PTSD do not include specific strategies for increasing positive affect nor is positive affect typically measured as an outcome in PTSD trials (Contractor et al., 2020). Positive affect is associated with decreased morbidity and mortality, improved sleep, increased social support and social connectedness, greater physical activity, and better mental health (Lyubomirsky et al., 2005; Steptoe et al., 2009). Thus, increasing positive affect among individuals with PTSD may exert several health benefits. CM specifically targets positive emotions by fostering gratitude and feelings of warmth, closeness, and connection towards others, as well as through its ultimate goal of cultivating self- and other-compassion (Ash et al., 2019). Our previous work demonstrated increased positive affect following CBCT-Vet (Lang et al., 2020), consistent with an MSC intervention among a general sample of veterans (Serpa et al., 2021). Here, we show that home meditation practice is associated with increased positive affect in Veterans with PTSD.

Adherence to home practice has been positively associated with treatment effects in other contemplative interventions such as mindfulness-based cognitive therapy (MBCT) and mindfulness-based stress reduction (MBSR) (Parsons et al., 2017), as well as traditional cognitive behavioral therapy (LeBeau et al., 2013). The findings from this study add to the existing literature by demonstrating that home practice in CBCT-Vet is related to improvements in depressive symptomology, negative affect, and positive affect among veterans with PTSD. Therefore, future research may wish to examine best strategies to promote home meditation adherence. A popular strategy that has been integrated with other interventions is motivational interviewing, a transdiagnostic therapeutic approach specifically designed to motivate and facilitate behavior change (Rollnick & Miller, 1995). Indeed, motivational interviewing has been previously proposed as a useful tool to facilitate home meditation adherence in CM-based interventions (Steindl et al., 2018). This may be particularly indicated for individuals experiencing high levels of symptomology. Previous research has found that individuals experiencing higher levels of depressive symptoms tend to engage in less home practice in MBCT compared to those with lower levels (ter Avest et al., 2021). In the current study, we found mostly small- to medium-sized correlations supporting a similar finding (data not shown).

Limitations and Future Research

This study has several limitations worth considering. This includes the relatively small sample size and the unequal group lengths, as well as the participants that were excluded from the study that did not have clinical outcome and/or meditation practice data. Future research is encouraged to determine if veterans with higher symptom severity at baseline are more likely to withdraw from CM-based interventions, suggesting other strategies may be indicated for initial symptom relief, and/or less likely to adhere to home meditation practice, suggesting that CM-based interventions may need to be adapted to increase engagement. Further, the sample consisted entirely of veterans/The extent to which results generalize to civilians with PTSD or other types of psychopathologies is unclear. We also did not have access to follow-up assessments because they were not included in either of the three studies in which data was pooled. Future research is encouraged to examine the durability of treatment-related improvements and the extent of continued meditation practice. Additionally, meditation practice from the previous week was reported at treatment sessions. To minimize bias, future studies may consider daily tracking via smartphone application to increase the accuracy of time spent in home meditation practice. Related, we were unable to assess practice quality (e.g., attention to the guided audio recordings, ability to bring to mind the suffering of another, etc.). Quality of home practice has been examined in MBSR, where greater practice quality (e.g., ability to experience bare sensations in the body) was associated with improvements in self-reported mindfulness (Goldberg et al., 2020). Given the quality of home practice is likely important in CM, future research is encouraged to develop practice quality measures specific to CM and assess the association between practice quality and treatment outcomes. Finally, findings reported in this study may have been influenced by common method bias (Podsakoff et al., 2012), which refers to spurious associations between self-report measures that occur as a result of particular response styles, social desirability, and priming effects that are distinct from the true associations among constructs.

In conclusion, home meditation practice was associated with significant improvements in depression symptoms, negative affect, and positive affect among veterans with PTSD participating in CBCT-Vet beyond the effect of treatment in general. This study provides support for the importance of home meditation practice to optimize treatment benefit, particularly around positive affect and negative affect, in CM-based approaches. This preliminary evaluation should be replicated and additional research is needed to identify optimal home practice dosing to maximize adherence while achieving clinically meaningful improvement.

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Author Contribution MSH conceptualized the study, assisted with data analyses, and wrote the manuscript. L.L. analyzed the data and wrote part of the results. A.M. collaborated with study conceptualization and writing of the manuscript. K.K. collaborated with study conceptualization and writing of the manuscript. P.C. collaborated with study conceptualization and writing of the manuscript. A.J.L. collaborated in the writing and editing of the final manuscript.

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Data Availability The authors were not allowed to publicly publish the dataset used in the current study. However, the authors will reply to any questions regarding the analyses and share information from the dataset upon request.

Declarations

Ethics Approval All study procedures were approved by the VA San Diego Healthcare System Institutional Review Board.

Informed Consent Prior to data collection, all participants provided informed consent.

Conflict of Interest The authors declare no competing interests.

References

Ansar, W., & Ghosh, S. (2013). C-reactive protein and the biology of disease. *Immunologic Research, 56*(1), 131–142. https://doi.org/10.1007/s12026-013-8384-0

Arimitsu, K., & Hofmann, S. G. (2017). Effects of compassionate thinking on negative emotions. *Cognition and Emotion, 31*(1), 160–167. https://doi.org/10.1080/02699931.2015.1078292

Ash, M., Harrison, T., Pinto, M., DiClemente, R., & Negi, L. T. (2019). A model for cognitively-based compassion training: Theoretical underpinnings and proposed mechanisms. *Social Theory & Health, 19*, 43–67. https://doi.org/10.1057/s41285-019-00124-x

Baca, S. A., Malaktaris, A., & Lang, A. J. (2018). *Using technology to expand the reach of meditation programs: A feasibility study of group compassion meditation training for veterans with PTSD delivered via telemental health*. Association for Psychological Science.

Buddhaghosa, B. (1975). *The path of purification* (Nanamoli, B., Trans.). Buddhist Publication Society.

Byllesby, B. M., Charak, R., Durham, T. A., Wang, X., & Elhai, J. D. (2016). The underlying role of negative affect in the association between PTSD, major depressive disorder, and generalized anxiety disorder. *Journal of Psychopathology and Behavioral Assessment, 38*(4), 655–665. https://doi.org/10.1007/s10862-016-9555-9

Chapin, H. L., Darnall, B. D., Seppala, E. M., Doty, J. R., Hah, J. M., & Mackey, S. C. (2014). Pilot study of a compassion meditation intervention in chronic pain. *Journal of Compassionate Health Care, 1*(1), 1–12. https://doi.org/10.1186/s40639-014-0004-x

Contractor, A. A., Weiss, N. H., Forkus, S. R., & Keegan, F. (2020). Positive internal experiences in PTSD interventions: A critical review. *Trauma, Violence, & Abuse*, 1524838020925784.https://doi.org/10.1177/1524838020925784

DePierro, J., D'Andrea, W., Frewen, P., & Todman, M. (2018). Alterations in positive affect: Relationship to symptoms, traumatic experiences, and affect ratings. *Psychological Trauma: Theory, Research, Practice, and Policy, 10*(5), 585–593. https://doi.org/10.1037/tra0000317

Desbordes, G., Negi, L. T., Pace, T. W., Wallace, B. A., Raison, C. L., & Schwartz, E. L. (2012). Effects of mindful-attention and compassion meditation training on amygdala response to emotional stimuli in an ordinary, non-meditative state. *Frontiers in Human Neuroscience, 6*, 292. https://doi.org/10.3389/fnhum.2012.00292

Dodds, S. E., Pace, T. W., Bell, M. L., Fiero, M., Negi, L. T., Raison, C. L., & Weihs, K. L. (2015). Feasibility of Cognitively-Based Compassion Training (CBCT) for breast cancer survivors: A randomized, wait list controlled pilot study. *Supportive Care in Cancer, 23*(12), 3599–3608. https://doi.org/10.1007/s00520-015-2888-1

Eber, S., Barth, S., Kang, H., Mahan, C., Dursa, E., & Schneiderman, A. (2013). The National Health Study for a New Generation of United States Veterans: Methods for a large-scale study on the health of recent veterans. *Military Medicine, 178*(9), 966–969. https://doi.org/10.7205/MILMED-D-13-00175

Fredrickson, B. L., Tugade, M. M., Waugh, C. E., & Larkin, G. R. (2003). What good are positive emotions in crisis? A prospective study of resilience and emotions following the terrorist attacks on the United States on September 11th, 2001. *Journal of Personality and Social Psychology, 84*(2), 365–376. https://doi.org/10.1037//0022-3514.84.2.365

Gueorguieva, R., & Krystal, J. H. (2004). Move over anova: Progress in analyzing repeated- measures data andits reflection in papers published in the archives of general psychiatry. *Archives of General Psychiatry, 61*(3), 310–317. https://doi.org/10.1001/archpsyc.61.3.310

Goldberg, S. B., Knoeppel, C., Davidson, R. J., & Flook, L. (2020). Does practice quality mediate the relationship between practice time and outcome in mindfulness-based stress reduction? *Journal of Counseling Psychology, 67*(1), 115–122. https://doi.org/10.1037/cou0000369

Gradus, J. L. (2007). Epidemiology of PTSD. *National Center for PTSD (United States Department of Veterans Affairs)*. https://www.mentalhealth.va.gov/coe/cih-visn2/Documents/Provider_Education_Handouts/Epidemiology_of_PTSD_Version_3.pdf

Grodin, J., Clark, J. L., Kolts, R., & Lovejoy, T. I. (2019). Compassion focused therapy for anger: A pilot study of a group intervention for veterans with PTSD. *Journal of Contextual Behavioral Science, 13*, 27–33. https://doi.org/10.1016/j.jcbs.2019.06.004

Hofmann, S. G., Grossman, P., & Hinton, D. E. (2011). Loving-kindness and compassion meditation: Potential for psychological interventions. *Clinical Psychology Review, 31*(7), 1126–1132. https://doi.org/10.1016/j.cpr.2011.07.003

Jazaieri, H., Jinpa, G. T., McGonigal, K., Rosenberg, E. L., Finkelstein, J., Simon- Thomas, E., Cullen, M., Doty, J. R., Gross, J. J., & Goldin, P. R. (2013). Enhancing compassion: A randomized controlled trial of a compassion cultivation training program. *Journal of Happiness Studies: An Interdisciplinary Forum on Subjective Well- Being, 14*(4), 1113–1126. https://doi.org/10.1007/s10902-012-9373-z

Kearney, D. J., Malte, C. A., Storms, M., & Simpson, T. L. (2021). Loving-kindness meditation vs cognitive processing therapy for Posttraumatic Stress Disorder among veterans: A randomized clinical rrial. *JAMA Network Open, 4*(4), e216604. https://doi.org/10.1001/jamanetworkopen.2021.6604

Kirby, J. N. (2017). Compassion interventions: The programmes, the evidence, and implications for research and practice. *Psychology and Psychotherapy: Theory, Research and Practice, 90*(3), 432–455. https://doi.org/10.1111/papt.12104

Klimecki, O. M., Leiberg, S., Lamm, C., & Singer, T. (2013). Functional neural plasticity and associated changes in positive affect after compassion training. *Cerebral Cortex, 23*(7), 1552–1561. https://doi.org/10.1093/cercor/bhs142

Kroenke, K., Spitzer, R. L., & Williams, J. B. (2001). The PHQ-9: Validity of a brief depression severity measure. *Journal of General Internal Medicine, 16*(9), 606–613. https://doi.org/10.1046/j.1525-1497.2001.016009606.x

Lang, A. J., Casmar, P., Hurst, S., Harrison, T., Golshan, S., Good, R., … & Negi, L. (2020). Compassion meditation for veterans with posttraumatic stress disorder (PTSD): A nonrandomized study. *Mindfulness*, *11*(1), 63-74.https://doi.org/10.1007/s12671-017-0866-z

Lang, A. J., Malaktaris, A. L., Casmar, P., Baca, S. A., Golshan, S., Harrison, T., & Negi, L. (2019). Compassion meditation for posttraumatic stress disorder in veterans: A randomized proof of concept study. *Journal of Traumatic Stress, 32*(2), 299–309. https://doi.org/10.1002/jts.22397

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. *Journal of Personality and Social Psychology, 92*(5), 887. https://doi.org/10.1037/0022-3514.92.5.887

LeBeau, R. T., Davies, C. D., Culver, N. C., & Craske, M. G. (2013). Homework compliance counts in cognitive-behavioral therapy. *Cognitive Behaviour Therapy, 42*(3), 171–179. https://doi.org/10.1080/16506073.2013.763286

LoParo, D., Mack, S. A., Patterson, B., Negi, L. T., & Kaslow, N. J. (2018). The efficacy of cognitively-based compassion training for African American suicide attempters. *Mindfulness, 9*(6), 1941–1954. https://doi.org/10.1007/s12671-018-0940-1

Lyubomirsky, S., King, L., & Diener, E. (2005). The benefits of frequent positive affect: Does happiness lead to success? *Psychological Bulletin, 131*(6), 803–855. https://doi.org/10.1037/0033-2909.131.6.803

Mascaro, J. S., Kelley, S., Darcher, A., Negi, L. T., Worthman, C., Miller, A., & Raison, C. (2018). Meditation buffers medical student compassion from the deleterious effects of depression. *The Journal of Positive Psychology, 13*(2), 133–142. https://doi.org/10.1080/17439760.2016.1233348

Najavits, L. M. (2015). The problem of dropout from "gold standard" PTSD therapies. *Fprime Reports, 7*, 43. https://doi.org/10.12703/P7-43

Pace, T. W., Negi, L. T., Adame, D. D., Cole, S. P., Sivilli, T. I., Brown, T. D., Issa, M. J., & Raison, C. L. (2009). Effect of compassion meditation on neuroendocrine, innate immune and behavioral responses to psychosocial stress. *Psychoneuroendocrinology, 34*(1), 87–98. https://doi.org/10.1016/j.psyneuen.2008.08.011

Podsakoff, P. M., MacKenzie, S. B., & Podsakoff, N. P. (2012). Sources of method bias in social science research and recommendations on how to control it. *Annual Review of Psychology, 63*(1), 539–569.

Parsons, C. E., Crane, C., Parsons, L. J., Fjorback, L. O., & Kuyken, W. (2017). Home practice in mindfulness-based cognitive therapy and mindfulness-based stress reduction: A systematic review and meta-analysis of participants' mindfulness practice and its

association with outcomes. *Behaviour Research and Therapy, 95*, 29–41. https://doi.org/10.1016/j.brat.2017.05.004

Post, L. M., Zoellner, L. A., Youngstrom, E., & Feeny, N. C. (2011). Understanding the relationship between co-occurring PTSD and MDD: Symptom severity and affect. *Journal of Anxiety Disorders, 25*(8), 1123–1130. https://doi.org/10.1016/j.janxdis.2011.08.003

Reddy, S. D., Negi, L. T., Dodson-Lavelle, B., Ozawa-de Silva, B., Pace, T. W., Cole, S. P., Raison, C. L., & Craighead, L. W. (2013). Cognitive-based compassion training: A promising prevention strategy for at-risk adolescents. *Journal of Child and Family Studies, 22*(2), 219–230. https://doi.org/10.1007/s10826-012-9571-7

Rollnick, S., & Miller, W. R. (1995). What is motivational interviewing? *Behavioural and Cognitive Psychotherapy, 23*(4), 325–334. https://doi.org/10.1017/S135246580001643X

Rutt, B. T., Oehlert, M. E., Krieshok, T. S., & Lichtenberg, J. W. (2018). Effectiveness of cognitive processing therapy and prolonged exposure in the Department of Veterans Affairs. *Psychological Reports, 121*(2), 282–302. https://doi.org/10.1177/0033294117727746

Schnurr, P. P., Lunney, C. A., Bovin, M. J., & Marx, B. P. (2009). Posttraumatic stress disorder and quality of life: Extension of findings to veterans of the wars in Iraq and Afghanistan. *Clinical Psychology Review, 29*(8), 727–735. https://doi.org/10.1016/j.cpr.2009.08.006

Serpa, J. G., Bourey, C. P., Adjaoute, G. N., & Pieczynski, J. M. (2021). Mindful self- compassion (MSC) with veterans: A program evaluation. *Mindfulness, 12*(1), 153–161. https://doi.org/10.1007/s12671-020-01508-1

Sheehan, D. V., Lecrubier, Y., Sheehan, K. H., Amorim, P., Janavs, J., Weiller, E., … & Dunbar, G. C. (1998). The Mini-International Neuropsychiatric Interview (MINI): The development and validation of a structured diagnostic psychiatric interview for DSM-IV and ICD-10. *Journal of Clinical Psychiatry*, *59*(20), 22-33.

Shonin, E., Van Gordon, W., Compare, A., Zangeneh, M., & Griffiths, M. D. (2015). Buddhist- derived loving-kindness and compassion meditation for the treatment of psychopathology: A systematic review. *Mindfulness, 6*(5), 1161–1180. https://doi.org/10.1007/s12671-014-0368-1

Steindl, S. R., Kirby, J. N., & Tellegan, C. (2018). Motivational interviewing in compassion- based interventions: Theory and practical applications. *Clinical Psychologist, 22*(3), 265–279. https://doi.org/10.1111/cp.12146

Steptoe, A., Dockray, S., & Wardle, J. (2009). Positive affect and psychobiological processes relevant to health. *Journal of Personality, 77*(6), 1747–1776. https://doi.org/10.1111/j.1467-6494.2009.00599.x

Taylor, S. L., Hoggatt, K. J., & Kligler, B. (2019). Complementary and integrated health approaches: What do veterans use and want. *Journal of General Internal Medicine, 34*(7), 1192–1199. https://doi.org/10.1007/s11606-019-04862-6

ter Avest, M. J., Greven, C. U., Huijbers, M. J., Wilderjans, T. F., Speckens, A. E., & Spinhoven, P. (2021). Prospective associations between home practice and depressive symptoms in mindfulness-based cognitive therapy for recurrent depression: A 15 months follow-up study. *Cognitive Therapy and Research, 45*(2), 250–261. https://doi.org/10.1007/s10608-020-10108-1

Vujanovic, A. A., Hart, A. S., Potter, C. M., Berenz, E. C., Niles, B., & Bernstein, A. (2013). Main and interactive effects of distress tolerance and negative affect intensity in relation to PTSD symptoms among trauma-exposed adults. *Journal of Psychopathology and Behavioral Assessment, 35*(2), 235–243. https://doi.org/10.1007/s10862-012-9325-2

Watts, B. V., Shiner, B., Zubkoff, L., Carpenter-Song, E., Ronconi, J. M., & Coldwell, C. M. (2014). Implementation of evidence-based psychotherapies for posttraumatic stress disorder in VA specialty clinics. *Psychiatric Services, 65*(5), 648–653. https://doi.org/10.1176/appi.ps.201300176

Weathers, F. W., Litz, B. T., Keane, T. M., Palmieri, P. A., Marx, B. P., & Schnurr, P. P. (2013). *The PTSD checklist for DSM-5* (PCL-5). Scale available from the National Center for PTSD at www.ptsd.va.gov

Weng, H. Y., Fox, A. S., Shackman, A. J., Stodola, D. E., Caldwell, J. Z., Olson, M. C., & Davidson, R. J. (2013). Compassion training alters altruism and neural responses to suffering. *Psychological Science, 24*(7), 1171–1180. https://doi.org/10.1177/0956797612469537

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