Effects of Heart Rate Variability Biofeedback with Mindfulness on Posttraumatic Stress and Depression in Veterans: Piloting a 3-Session Protocol

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Purpose

The purpose of this waitlist randomized controlled pilot study was to test a 3-session heart rate variability (HRV) biofeedback protocol that included mindfulness training (HRVBm) and a mobile app for home practice. We hypothesized that the mobile app-adapted version of HRVBm would:

- reduce posttraumatic stress disorder (PTSD) and depression symptoms
- improve time and frequency domain indicators of HRV,
- be feasible and acceptable to veterans with a PTSD diagnosis

Background

Many veterans continue to struggle with PTSD and depressive symptoms, even after completing a full course of treatment (Larsen et al 2019). HRVB interventions using cardiorespiratory training and physiological feedback to increase HRV, have proven efficacious in treating PTSD (small effects) and depression (medium effects; Lehrer et al., 2020 and have ranged from 1-to 18 sessions (Kizakevich et al., 2019; Pyne et al., 2019; Schuman & Killian, 2019). Mindfulness practices (breath and present-centered awareness) are inherent in traditional biofeedback approaches and approaches have incorporated specific mindfulness training (Khazan, 2013). Additional research is needed to determine optimal number of sessions, best ways to reinforce skills learned in sessions (e.g., use of home practice), and feasibility and acceptability to veterans with PTSD.

Method

Veterans, 18-75, with clinically-defined military-related PTSD were recruited from a local Veterans Administration (VA) hospital and local Vet Center. Those with significant psychological or physical illness were excluded. N = 35 participants, aged 29 to 75 (*M* = 50.11, *SD* = 14.47), 13.9 % women (*n* = 5) and 8.3% Non-White (*n* = 3) were enrolled and randomized into two groups: intervention (*n*=18) and waitlist control (*n*=17). Outcome variables included PTSD (PCL-5), depression (BDI-II), electrocardiogram (ECG)-derived HRV (i.e., SDNN, RMSSD, LF, HF), feasibility (70% completion rate), acceptability (practice rate during the follow-up period), and adherence (total minutes of home practice). Nexus 10 Mark II was used to measure respiration and ECG; An app with an emWave device and Bluetooth sensor was used for home practice and to measure adherence. Clinical training was conducted with Alive (Somatic Vision). Participants in the intervention group were instructed to practice twice daily, five minutes each time. All measures were assessed before (Time 1: T1) and after 3 clinical sessions (Time 2; T2), and at 8-week follow-up (Time 3; T3). See protocol elements below (Figure 1).

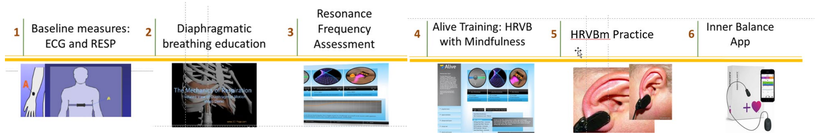

Figure 1
Protocol Elements

Findings

Table 1

Two-Way Analyses of Variance for PTSD and Depression

	Main effect of time				Group x Time interaction effect				Main effect of group			
PTSD	***F***	***df***	***p***	n^2p	***F***	***df***	***p***	n^2p	***F***	***df***	***p***	n^2p
PCL-5 Total	6.755†	2, 66	0.002*	0.17	1.315†	2, 66	0.275	0.038	.229†	1, 33	0.635	0.007
B (Intrusion)	6.771†	2, 66	.002*	0.17	2.847†	2, 66	0.065	0.079	.905†	1, 33	0.348	0.027
C (Avoidance)	7.103†	2,66	.002*	0.177	.957†	2, 66	0.389	0.028	.182†	1, 33	0.673	0.005
D (NACM)	4.981††	2, 66	.01*	0.131	.863††	2, 66	0.427	0.025	.046††	1, 33	0.832	0.001
E (AAR)	1.656	2, 66	0.199	0.048	0.248	2, 66	0.781	0.007	0.776	1, 33	0.385	0.023
Depression												
BDI-II	7.688	2, 66	>.001*	0.189	4.051	2, 66	0.022*	0.109	0.149	1, 33	0.702	0.005

Note. Abbreviations: Beck Depression Inventory-II (BDI-II); PCL-5: Posttraumatic Stress Disorder Checklist for *DSM-5*; NACM: Negative alterations in cognitions and mood; AAR: Alterations in arousal and reactivity. Descriptive statistics are provided for raw data. Mixed ANOVA tests were conducted after square root transformation from imputed data (EM algorithm). *Significant ($p < .05$), two-tailed; †Huynh-Feldt; ††Greenhouse Geisser

Table 2

Two-Way Analyses of Variance and Covariance for Heart Rate Variability

	Main effect of time				Group x Time interaction effect				Main effect of group			
HRV												
Time	***F***	***df***	***p***	n^2p	***F***	***df***	***p***	n^2p	***F***	***df***	***p***	n^2p
SDNN Ln (ms)												
HRVBm (*n*=18)	3.89	2,64	.03*	.11	4.75	2,64	.012*	.13	4.52	1,32	.04*	.12
WC (*n*= 17)												
RMSSD Ln (ms)												
HRVBm (*n*=18)	1.46	2,64	.24	.04	2.60	2,64	.08	.08	3.78	1,32	.06	.11
WC (*n*= 17)												
	Main effect of time				**Group x Time interaction effect**				**Main effect of group**			
Frequency	***F***	***df***	***p***	n^2p	***F***	***df***	***p***	n^2p	***F***	***df***	***p***	n^2p
LFnu												
HRVBm (*n*=18)	3.74	2,66	.03*	.10	1.49	2,66	.23	.04	.97	1,33	.33	.03
WC (*n*=17)												
HFnu												
HRVBm (*n*=18)	3.72[a]	2,66	.03*	.10	1.48[a]	2,66	.24	.04	.972[a]	1,33	.33	.03
WC (*n*= 17)												

Note. Abbreviations: SDNN: Standard deviation of normal-to-normal RR intervals; RMSSD: Root mean square of successive RR interval differences; HFnu: High frequency (refers to HRV frequency band, 0.15-0.4 Hz), in normalized units (nu); LFnu: Low frequency (refers to HRV frequency band, 0.04-0.15 Hz) in normalized units (nu). Note. For ANCOVA and ANOVA, SEs and SDs are from imputed data using the expectation-maximization (EM) algorithm. Covariates appearing in the model for SDNN Ln and RMSSD Ln are evaluated at the following values: Age at time of enrollment = 50.60; *Significant effects ($p < .05$; [a]Huynh-Feldt; for HFnu and LFnu, age was not significantly correlated with the dependent variables, and was removed from the model to increase power.

Although a significant group x time interaction effect was not found for the PTSD symptom score, there was a marginally significant group x time interaction effect for Cluster B (intrusion), $F(2, 66) = 2.847$, $p = .065$, $\eta^2p = .079$. See Table 1. Post hoc tests with Bonferroni correction showed a significant decrease in PTSD symptoms for the HRVBm group from T1 to T2 ($p = .015$; Cohen's $d = .720$) and T1 to T3 ($p = .030$; Cohen's $d = .522$). There was also a significant group x time interaction for BDI-II total scores, $F(2, 66) = 4.051$, $p = .022$, 109. See Table 1. Post hoc tests with Bonferroni correction showed a significant decrease in depression symptoms for the HRVBm group from T1 to T2 ($p = .002$; Cohen's $d = .618$) and T1 to T3 ($p = .001$; Cohen's $d = .817$). Controlling for age, the HRVBm group saw a significant group x time interaction on SDNN, $F(2, 64) = 4.75$, $p = .012$, $\eta^2p = 129$. See Table 2. Post hoc tests with Bonferroni correction showed a significant increase in SDNN for the HRVBm group from T1 to T2 ($p = 0.036$; Cohen's $d = .553$). Waitlist group results were not significant. Results of a Pearson correlation indicated a significant positive association between total number of minutes of verified use and change in natural log-transformed SDNN from T1 to T3, ($r = 0.626$, $p = .039$, 95% CI [0.042, 0.891]). Over 70% completed the clinical trainings and returned for follow-up. Home practice was verified for only 12. Of these, only 27% completed at least 70% of the recommended number of minutes of home practice.

Conclusion

Findings indicated the 3-session protocol marginally improved PTSD Cluster B intrusion symptoms and significantly improved depression symptom severity (large effects) and SDNN (medium effects) in the HRVBm group, but not the waitlist control. SDNN was positively correlated with minutes of home practice. The protocol was feasible and acceptable to veterans with PTSD based on the 70% completion rate for study visits. Results suggest that a 3-session HRVBm protocol, augmented by twice-daily home practice using a mobile health device, may improve autonomic functioning and address comorbid depression in veterans with PTSD. The next phase of intervention development should address strategies for increasing participant adherence.

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