FEATURE ARTICLE

Perspectives on Research on the Use of Heart Rate Variability Biofeedback for Combat-Related Posttraumatic Stress Disorder

J. P. Ginsberg, PhD1,2 and Wendy Fogo, MA2

1Dorn VA Medical Center, Columbia, SC; 2Dorn Research Institute, Columbia, SC

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The process of doing interventional research using a randomized clinical trial design to test the efficacy of heart rate variability (HRV) biofeedback as a treatment for combat-related posttraumatic-stress disorder (PTSD) in Veterans with PTSD is described from two perspectives: by the study Principal Investigator and by one of the research staff. The history, context, and results of the study are briefly presented.

Introduction

Currently, there are few reliably effective treatment options for patients suffering from post-traumatic stress disorder (PTSD). In addition, associated deficits in attention and immediate memory remain a problem for everyday adjustment for patients with PTSD. While lowered heart rate variability has been shown to be associated with PTSD, this association has not been well-studied. Heart rate variability (HRV) biofeedback is a novel technique that has successfully been used to treat patients with various medical and psychiatric conditions. Our team at the Dorn Veteran’s Administration Medical Center is using HRV biofeedback to moderate PTSD symptoms and reduce deficits in attention and immediate memory in postcombat veterans. We anticipated that the HRV biofeedback used in this study would reduce or eliminate deleterious physiological and cognitive effects associated with PTSD, and improve functional adjustment to everyday and acute stressors in combat veterans with PTSD.

We had preliminary data from a small-scale pilot study showing that HRV biofeedback reduced false alarms on a continuous performance test and increased word list learning and digit span. We used those preliminary results in a proposal to the Congressionally Directed Medical Research Program (CDMRP) of the Department of Defense, and were awarded a grant to extend the preliminary findings to a larger population of Operation Iraqi Freedom/Operation Enduring Freedom (OIF/OEF) veterans. Patients enrolled in the present study were first assessed by a clinical psychologist for PTSD, monitored in the lab for baseline, resting HRV, and then underwent a battery of cognitive tests. The veterans then were classified as being with or without PTSD (PTSD+ or PTSD−, respectively), based on results of the psychological assessment. PTSD+ participants were then randomly assigned to either learn a validated HRV biofeedback technique with a trained biofeedback practitioner, or to a sham training condition, also with a biofeedback practitioner, in which case the participant received only general relaxation instruction (e.g., “just relax,” “try not to worry”) without any computer screen feedback. Both groups received 6 weeks of training, followed by a posttraining assessment of PTSD, HRV, and cognition identical to the pretraining assessment.

The use of an HRV biofeedback intervention for treatment of PTSD is novel and at an early stage of its development. Our study is intended to demonstrate that the effect of the HRV biofeedback intervention is an amelioration of psychological symptoms and cognitive deficits of PTSD, and that the mechanism of effect is mediated through HRV. The demonstration of a statistical association between HRV biofeedback and the outcome measures alone would not be sufficient to rule out the possibility that the effects are due to another, unidentified factor. However, collection of HRV data allows us to determine the degree to which increases in HRV power occurred as a result of the active vs. sham training, as well as the degree to which observed increases are related to changes in the outcome measures, PTSD and cognition.

Wendy Fogo, the Project Research Assistant Writes

I came to Dr. Ginsberg’s research lab as a graduate student working on my PhD. My clinical interests are in anxiety and specifically PTSD and my research interests lie with...
disaster response, on both an organizational and an individual level. My dissertation is focusing on defining the concept of a survival mindset and creating a measure that can be used to study the concept more accurately. I was initially interested in working in this lab for the opportunity to work with veterans with PTSD as well as to gain some additional experience in data management and analysis. During my time here, I have gained a deeper understanding of the value of HRV and biofeedback, which has increased my overall interest in psychophysiology.

I believe that my training in clinical psychology was an asset that helped prepare me for many of the tasks required for working in Dr. Ginsberg’s research lab. I was easily able to take on responsibilities such as recruiting participants, reviewing the consent forms with them, and providing the necessary psychological evaluations. I was familiar with all of the mental health assessment tools that were implemented in the study and had a moderate understanding of the principles of biofeedback. However, while I have comprehensive data analysis skills, what I struggled with most was understanding HRV in general, and in particular, the meaning of the data and even the variables that we were collecting.

My first challenge in working with HRV data was my general unfamiliarity with it. A heart rate recording of just a few minutes results in a large number of data points. It also yields a number of different types of variables, such as scores for total power, peak power, peak frequency, and a headache-inducing number of acronyms related to things like power, and means and standard deviations of those scores. One of my very first tasks was getting up to speed with the literature on HRV, specifically, learning what these scores meant and how they were derived. In order to gain a better understanding of what we were doing, I read the grant proposal and selected readings provided to me by Dr. Ginsberg. Dr. Ginsberg was also generous with his time in explaining the concepts to me and allowing me to ask questions, and in orienting me to the different variables in the datasets. Further, our biofeedback clinician, Jane Arave, demonstrated for me exactly what she does in a typical biofeedback session for the study and allowed me to observe as she provided a mock session to another research assistant in our lab. These helped me gain a preliminary understanding of the topic of HRV.

My initial experience in this lab was with HRV data from a pilot study of continuous recording of day and night shift nurses. While the number of participants in the study wasn’t large, the amount of data was remarkable compared to datasets that I had used in the past. It was filled with lines of data, containing at least one hundred thousand data points per participant. I quickly learned that working with HRV data required innovative approaches to data management and alternative methods of processing the data. For example, in Excel, it was much more efficient to teach myself keyboard shortcuts to select data when writing formulas than it was to select data with the mouse, which took several minutes of scrolling through to select all of the data. While in the past, I had no use for macros in working with my data, they became important tools for HRV data.

As I learned more about HRV and biofeedback, and increased my comfort in the research lab, my position transitioned into one that included mentor and teacher. Because there were several other research assistants—as well as undergraduates who came to observe the research process—that were less familiar with psychological principles or had less experience with the intervention side of the research, I had a number of opportunities to help educate them on the different aspects of the study. I discussed the specific measures that we used and explained why they might be important to our study, helped orient them to the research questions that we were asking, and discussed the process that each participant went through as they completed the study. I think that this process of coming in and using what I knew already, learning the new concepts, and passing those concepts along to others who were interested in the research was a valuable experience for me and for those who have taken the time to learn more about the research.

I came to this research lab with a moderate understanding of biofeedback, but little practical experience in it. Originally, I was drawn to Dr. Ginsberg’s research because of my interest in PTSD and in working with veterans. I had a small knowledge of biofeedback but no experience in the heart rate variability aspect of his research. As I learned more about it, however, it became clear that there were a number of interesting possibilities for applying HRV to my research interests in response to disaster. As Dr. Ginsberg has shown, HRV biofeedback can lead to positive outcomes in PTSD level. He is also furthering his research by examining HRV in relation to the orienting response by doing heart rate recordings during an attention task. I’m especially curious about this research as it relates to PTSD symptoms and additionally, the implications it may have for understanding survival at the moment a traumatic incident occurs. It would be interesting to me to use my dissertation measure to understand the relationship between possessing a survival mindset and HRV characteristics during an attention task. Further, it may be interesting to measure HRV variables during a simulation of a disaster event.

Another result of my increased knowledge of HRV biofeedback was an increased interest in the clinical use of it. Because working with PTSD veterans is a clinical interest of mine, I am interested in learning more about the ways that
HRV biofeedback can be incorporated into PTSD treatment, as an additional tool that veterans can use to help reduce PTSD symptoms. There are now clinicians at the VA who are very interested in offering HRV biofeedback to veterans, and there may be new opportunities for me to learn the specific techniques and implement them in a clinical setting. I’m excited about the possibility of being able to work with HRV biofeedback from yet another perspective.

The research at the Dorn Veteran’s Administration on HRV has helped to spark interest and facilitate the acceptance of it at this institution. In general, it seems that practitioners have little experience with biofeedback and administrators are even less familiar with the recent literature, making it difficult to implement biofeedback in a clinical setting. However, our research lab has had opportunities to work with clinicians to help further the use of biofeedback. Research has been conducted with practitioners in the pain clinic and there are plans for a study in the pain clinic as well. Further, there have been recent dialogues about the possibility of introducing biofeedback into the primary care setting. Dr. Ginsberg has been encouraging of this idea, offering his expertise, some equipment, and encouraging his research assistants to get involved in this effort in any way.

Retrospective

Three years have passed since the proposal was funded. We finished the active data collection phase and are currently analyzing the results. We enrolled 76 combat veterans total, 15 PTSD− and 61 PTSD+ (29 randomized to active HRV biofeedback training, 32 to sham training). PTSD− participants had statistically higher SDNN, RMSSD, HF power, and word list learning scores than the PTSD+ group before the PTSD+ group received any training (see Inset Box). The study was given a high quality rating of likelihood of nonbias, based on its design of randomization to treatment, blinding of assessors, and planned inclusion of non-completers in analyses. The intervention was successful, shown by no difference in any HRV measure between PTSD+ groups pretraining, and significantly greater SDNN, RMSSD, and log peak LF frequency in the active training group compared to the sham group posttraining. Although preliminary, we already know from mixed model analysis (HRV biofeedback vs. sham feedback, pre- vs. posttraining) that the interaction of Group × Time is significant for PTSD, depression, and general mental health, showing greater improvement for the active HRV biofeedback group. We are in the process of analyzing the cognitive data. Much work remains to be done in refining the analyses to include numerous relevant covariates (e.g., chronicity of PTSD, medications, medical history and comorbid conditions, just to name a very few) and more complex forms of statistical modeling.

The progress of research is slow, with long time horizons. This work has required the committed efforts of many people not mentioned here. We believe that the potential for benefit to the lives of those in need of PTSD treatment is great, and that in the future scientific understanding of the relationship between HRV and PTSD will be deepened by randomized clinical trials such as this one.

Inset Box: Heart Rate Variability Measures Used in the Study

We measured inter-beat interval in milliseconds as the peak-to-peak time interval between successive blood pulse volume (BPV) waves recorded with finger-tip photoplethysmograph (PPG), after correcting for trend and artifact (e.g., missed and extra beats, ectopic beats). Thus, a heartbeat was defined as the time at which maximum BPV occurred.

SDNN is the standard deviation of the interval between successive BPV maxima.

RMSSD is the root mean square of successive differences in interval between BPV maxima (i.e., between neighboring inter-beat intervals).

HF power is a time domain measure for heart rate variability, and refers to the power in the high frequency range in the spectral distribution in heart rate variability.

The log peak LF frequency is the peak frequency within the low frequency range of heart rate variability, transformed into a logarithmic value.