An Experimental Study on the Effects of Deep Touch Pressure on Emotion Soothing

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Abstract: Stress, anxiety, and depression are normal reactions to a variety of stressors and have a detrimental effect on mental or physical well-being. An experimental study on the effects of deep touch pressure on emotion soothing was carried out. The study used an automated pressure vest and measured participants' vital signs and emotions before and after being exposed to a stressor. Secondly, an automatic pressure vest was used to explore the effects of deep touch pressure on emotion soothing. The State-Trait Anxiety Inventory, a self-rating anxiety scale, and electroencephalogram (EEG) readings measure deep touch pressure effects on anxiety reduction. The research found that the pressure vest helped to reduce stress and improve relaxation. It also found that the pressure vest induced a high theta in the prefrontal lobe of the brain, indicating that the participants became more relaxed. The study suggests that deep touch pressure may be an effective, non-pharmacological method for reducing stress, anxiety, and depression.

Keywords: Pressure Vest; Stress; Anxiety; Depression; Deep Pressure

Introduction

Stress is a common experience for humans and it can manifest in a variety of ways, including physical symptoms, emotional distress, and cognitive impairments. Stress is a normal response to certain situations, but chronic stress can lead to a wide range of health problems, including cardiovascular disease, mental health issues, and decreased immunity (S. Baez-Lugo, 2023) (D. B. O'Connor, J. F. Thayer, and K. Vedhara,2021). Deep pressure, which is the application of firm but gentle pressure to the body, has been shown to be an effective method for reducing stress in human beings(S. M. M. G. E. D. C. R. K. Edelson and G. Temple, 1999).

This study aims to present early thoughts and methods for implementing a simple, automated pressure vest for individuals with stress, depression, and anxiety disorders. The automatic pressure vest is designed and completed using the knowledge of the effects of deep touch pressure on human emotions and psychology, pulse sensors, pressure sensors, miniature air pumps, air valves, pressure vest, and Arduino microcontroller-related knowledge. We began by studying how to monitor heart rate signals using simple logical control to develop an algorithm. Furthermore, given the dynamic nature of human systems, there are a multitude of reasons why users or therapists may find pressure vests beneficial. This study aims to see how deep touch pressure affects emotion soothing.

Experimental Considerations

Volunteers

Adults who were enrolled in or who were employed at Jiangsu University were among the participants in the experiment. As a result, the study carried at least 11 volunteers in total.

Data Collecting Instruments

Data collection involves accumulating and measuring statistics systematically, which simplifies hypothesis testing and

the effective answering of the research questions on variables of interest(S. Muhammad and K. Sajjad, 2016). Vital sign machines were used to gather the required data. Blood oxygen saturation and heart rate were measured using a pulse oximeter. Blood pressure was measured using a digital blood pressure machine.

Experiment Apparatus

A pulse oximeter was used to measure pulse rates. Pulse rate is essential as a measure of anxiety and to assure patient safety. The State-Trait Anxiety Inventory for Adults is a shorter version of the STAI with outstanding psychometric characteristics, reliability, and validity. The State-Trait Anxiety Inventory for Adults was employed for this investigation since the lengthier version was deemed unsuitable in this situation. The shorter version produces comparable results to the more extended version and is still responsive to variations in state anxiety. An individual's total state anxiety score is calculated, with a higher number indicating anxiety.

Experiment Procedure

The participants were given a brief explanation of the research design and consent form, and if they chose to participate in the study, they signed and retained a copy of the paper. The information was gathered in two methods. In the patient's chart, one copy was kept. The duplicate was given a number, either even or odd, based on the sequence in which they arrived at the event. The gender and age of each participant were recorded. The voluntary participation document provided an overview of the investigation's equipment and techniques and the potential issues of participating in the study. Individual briefings of the experiment's protocols were given to each volunteer prior to the start of the session. The chance for participants to ask questions was provided, and they had their doubts cleared before signing the voluntary participation form. The individual's pulse rate, blood pressure, blood oxygen saturation, and EEG were all observed and recorded. The participants were asked 20 questions from the State-Trait Anxiety Inventory for Adults. Their responses were recorded both before and after each session, and they took a self-anxiety evaluation survey at the end. All participants took part in two test sessions, one with an automated pressure vest and one without, which functioned as the control experiment. 8-minute time intervals with and without the automated pressure vest were used for this experimental study. To counter the order effect, volunteers participated in the experiment with or without the vest depending on the order of the number they came for the participation that is either an even or odd number participation sequence was employed. Depending on which experiment they started with, volunteers watched an emotional video to help trigger an emotional response, after which the vest was inflated, or they relaxed without the vest being inflated. Before and after each experiment, vital signs were recorded, as well as a State-Trait Anxiety Inventory for Adults survey. During each experiment, EEG and heart rate were continuously recorded. Between testing sessions, volunteers were given a five-minute break during which their vital signs were collected and they were asked to complete a State-Trait Anxiety Inventory for Adults survey. The researchers were present the entire time, and the automatic pressure vest remained in place. For consistency, blood pressure, heart rate, and blood oxygen saturation were taken on the left side, while EEG was recorded simultaneously. A data-recording protocol manual was used to organise data collection and ensure that all participants' data acquisition was uniform throughout the research.

Results And Analysis

State-Trait Anxiety Inventory (Stai) Interpretation

One of the most prominent traits and state anxiety measures is the State-Trait Anxiety Inventory (STAI). Diagnoses of anxiety and the distinction between it and depressive disorders can be made in clinical settings by using this test. Each participant's self-rating anxiety before and after treatment was examined using data gathered from the State-Trait Anxiety Inventory for Adults. It may be determined if the usage of the automated pressure vest has a more significant impact on self-perceived anxiety by comparing the findings of a short form of the State-Trait Anxiety Inventory for Adults (Short Form). Exit survey responses and scores from the State-Trait Anxiety Inventory for Adults (Short Form) are used to determine if there was an ordering effect during the experiment. Higher scores are associated with greater levels of anxiety.

On average, people who used the vest scored worse than those who did not use it.

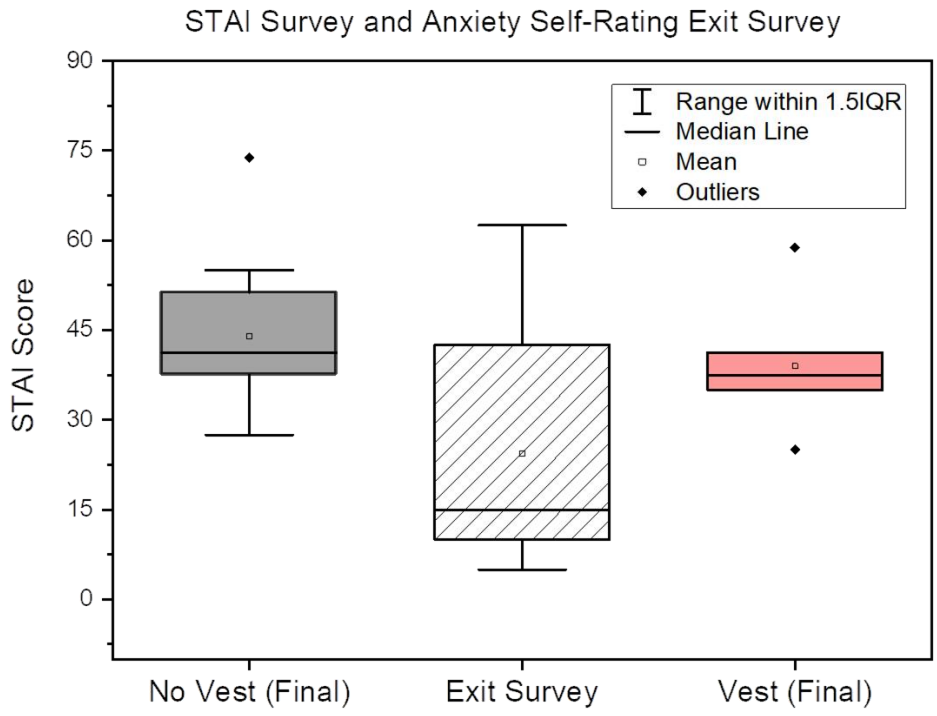

Figure 1. STAI And Exit Survey Box and Whisker Plot

All values were changed to percentages for easy calculations and comparison. The mean value for the therapy without the pressure vest is 43.97727273 and for the experiment with the pressure vest is 38.97727273. However, the mean value of the exit survey is very low compared to the STAI final survey of the therapy and the control experiment as shown in figure 1. A paired t-test was taken between the final STAI final of the investigation with the vest and without the vest to evaluate whether there was an ordering effect. Using alpha as 0.01, P(T<=t) two-tail=0.019800271 between the control and the exit survey, P(T<=t) two-tail=0.151032494 between the therapy with the vest and the control. In these two sets of calculations, there was no significant ordering effect between the tested parameters. P(T<=t) two-tail=0.001636719 between the therapy with the vest and exit survey signifying an order effect.

This was possibly due to carryover effects in which the participants may have to respond to the experiment due to repetition of the procedure either with or without the vest. In this experiment which involved repeated measurements of the same individuals, one or more order effects was expected to appear. The order effects skew the results, as shown in the box and whisker plot. A relatively more significant portion of the participants had a relatively high anxiety score after the control experiment with vest than in the therapy. A Pearson R statistical test was conducted, which measures the strength between the different variables and their relationships. Pearson Correlation=0.559563671 between the survey after the experiment with the vest and the exit survey and the survey after the control experiment and the exit Pearson Correlation=0.682352099 all of which are relatively high absolute values of the correlation coefficient, which indicates a stronger relationship between surveys.

BLOOD PRESSURE (BP)

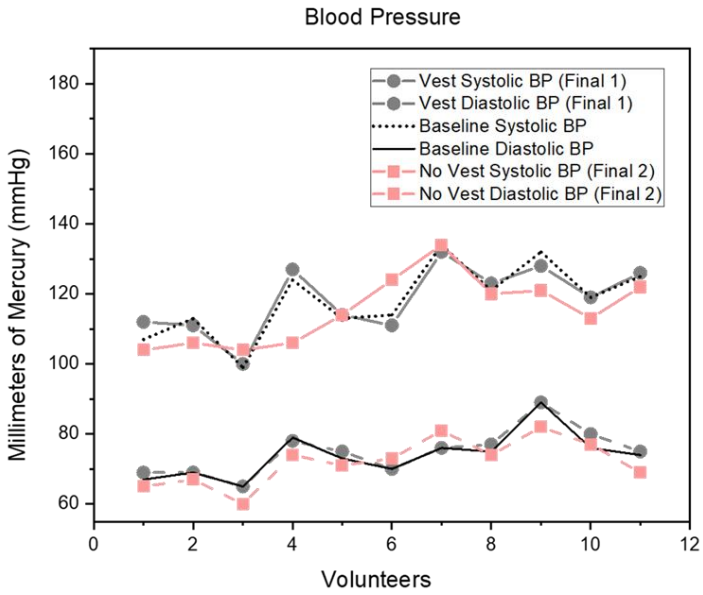

Figure 2. Blood Pressure-Line graph

Due to different reasons, the participants had generally high, average, or low blood pressure. In order to test a reasonably good comparison of the participant's blood pressure, three sets of blood pressure, namely the baseline, which was taken from the initial blood pressure readings of the control experiment, the final readings of the therapy session with the vest and the final readings of the control experiment. The line graph (figure 2) shows that the vest was not one of the reasons for either low or high blood pressure. Therefore, to further ascertain this conclusion, we implored a paired t-test between the baseline and the final blood pressure readings of the therapy session with the vest.

Alpha as 0.05 P(T<=t) two-tail=0.828613681 for systolic blood pressure and P(T<=t) two-tail=0.063645884 for diastolic blood pressure, both of which are greater than 0.05; therefore, we concluded that there is no evidence that the vest caused either high or low blood pressure in participants. Other variables may have contributed to the high or low blood pressure, such as anxiety due to the experiment or the high amount of caffeine.

In conclusion, the results acquired from the three separate vital sign tests suggest that the usage of the automated pressure vest did not lead the subjects to enter a dangerous physiological range. All 11 participants' SpO2 levels remained over 95%, and their pulse rates remained below 100 beats per minute.

Feature Selection And Extraction

The primary goal of the research is to determine the relationship between EEG and deep pressure. This relationship may be employed in everyday situations to assist individuals in need of deep pressure. Selecting appropriate brain areas and bands was critical since a 62-channel electrode cap is not suitable for this purpose. The fundamental goal of feature extraction is to find the most important elements that may be used to map EEG data to emotional states. The Fourier transform (Welch approach) was used to translate time domain information into frequency domain information. The power spectrum of all sub-epochs within each epoch was then averaged to reduce EEG artifacts in all sub-windows. Finally, the EEG log power spectrum was extracted into several frequency bands, including delta, theta, alpha, beta, and gamma(S. M. Alarcão and M. J.2019). . Since the sample rate was no longer 1000Hz, the data sampling rate was reduced to 250Hz, and each epoch had 500-time points. A 100 data point window, and a 50% window overlap were used. The Fast-Fourier Transform was set to 512. In the traditional way, neural oscillations were divided by frequency into theta (4-7Hz), alpha

(8-12Hz), beta (13-30Hz), and low-gamma bands (30-45Hz) (X. W. Wang,etc.,2011). Previous research has shown that neural oscillations in the frontal and parietal lobes are associated with relaxed emotions. Therefore, the regions of interest (ROI) were set as the frontal and parietal lobes. The F1, Fz, F2, AFz, and FCz electrodes were selected as frontal lobe ROI. P1, Pz, P2, CPz, and POz electrodes were selected as parietal ROI. The average power of ROI channels was compared between the two groups.

Results

In both conditions, the power spectrum showed high power alpha-band activity. This was reasonable because, in both conditions, the subjects were resting in a relatively relaxed environment. A paired t-test was carried out on the two separate conditions, one with a pressure vest and the control without a pressure vest on the frontal ROI and parietal ROI on EEG delta, theta, alpha, beta, and gamma asymmetry values. T-test of paired samples showed that the theta power of the frontal lobe differed significantly between groups (p=0.0426).

Table 1. Statistical analysis of the two conditions on different lobes.

Table Analyzed	theta-PFC	theta-parietal	alpha-F7
Paired t test			
P value	0.0426	0.0304	0.031
P value summary	*	*	*
Significantly different (P < 0.05)?	Yes	Yes	Yes
One- or two-tailed P value?	Two-tailed	Two-tailed	Two-tailed
t, df	t=2.360, df=9	t=2.566, df=9	t=2.554, df=9
Number of pairs	10	10	10

Although no significant difference in theta in parietal ROI was found between groups, however, a significant difference (p=0.03) in theta power was found in the left parietal lobe (the mean power of CP3, CP5, P3, P5). Acknowledged as distinct theta activity on EEG in the frontal midline area, this activity implies mental focus as well as a contemplative state or anxiety reduction. The analysis of frontal alpha F7 EEG values revealed that there is a significant difference between the two conditions. Paired t-test p value=0.031, $p < 0.05$. In order to understand this interaction, separate analyses were conducted for each condition. The prefrontal lobe was associated with cognitive control, and alpha waves indicated relaxation or rest. These analyses revealed that alpha is concentrated in the occipital lobe under both conditions. However, there were subtle differences in their frontal lobes, suggesting the subjects were more relaxed in the second condition.

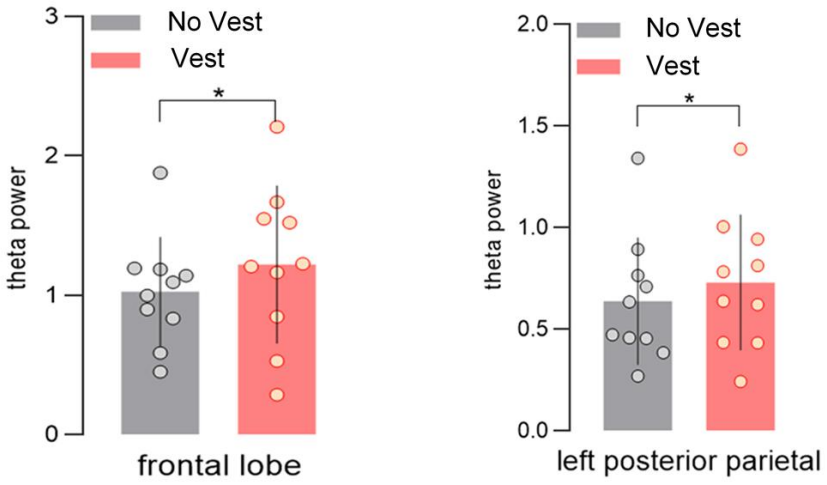

Figure 3. Theta power between groups (paired t-test)

The difference between the Theta oscillation in the prefrontal lobe and the left posterior parietal lobe was significant, as was mean power. Condition 2 induced a high theta in, for example, PFC compared with condition 1, therefore, leading to a conclusion that patients become more relaxed in the second condition.

According to our data analysis, the frontal and parietal lobes are the most informative regarding emotional states, alpha, gamma, and theta waves proved to be the most discriminative. The frontal mid-line theta rhythm, which is identified on EEG as unique theta activity in the frontal mid-line region, shows mental attention as well as a contemplative state or anxiety reduction. Theta waves in the prefrontal lobe and alpha waves in the posterior parietal lobe and occipital lobe were found during meditation, meaning that sitting quietly may immediately bring the body and mind back to their most harmonious, relaxed state(J. Lagopoulos.2009). This, therefore, explains why the participants were relaxed in both conditions, with theta differentiating the relaxed conditions (Figure 3).

Conclusion

Overall, it was concluded that using an automated pressure vest to apply deep touch pressure can help reduce stress, anxiety, and depression, offering a novel, non-pharmacological, and complimentary way to calm emotions. Possible limits were outlined as well as future studies while highlighting our findings in the context of professional practice. This study provides direction and purpose to researchers who want to conduct future research on the evaluation of a clinically viable therapy method. Further research on the use of a pressure vest with people who have high levels of anxiety is needed. More research into the possibility of developing new technologies for remote sensing of anxiety, as well as novel deep pressure devices adapted to individual needs and preferences, may be needed in the future.

Ethical Approval

The study was conducted according to the guidelines of the Declaration of Helsinki and approved by the Institutional Review Board of Xuzhou Central Hospital (protocol code XZXY-LJ-20210513-054 and May 13rd, 2021). Informed consent was obtained from all subjects involved in the study.

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