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The Effects of Meditation and Music on Stress in College Individuals

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Abstract

Background: Stress is a universal experience, now more than ever due to an ongoing worldwide pandemic. Modern college students are not only faced with the external pressures of succeeding academically, but they're also affected by a multitude of other variables that are causing their mental health to suffer. This social trend highlights the need for a simple, efficient, and immediate remedy for individuals suffering from these stressors. **Objective:** In this controlled study, we assessed the effects of two methods proven by existing research to have stress-relieving effects. Participating college students underwent music (Weightless by Marconi Union) and mindfulness meditation (Daily Calm) treatments. **Methods:** Ten college students were screened via a self-reporting questionnaire to identify any pre-existing conditions that may present as extraneous variables. Quantitative variables related to stress, such as alpha frequency waves and heart rate, were obtained during baseline and post-treatment stress-induced environments using an iWire EEG recorder and oximeter pulse monitor. Each individual underwent treatments for a duration of five minutes, each with noise-canceling headphones. Students were placed in an experimental stressor state induced by the Stroop test, which provided baseline stressor data. Subsequently, participants underwent each treatment, recording their heart rate before and after each. Upon each treatment's conclusion, the Stroop test was administered again while alpha wave data was recorded. The final data set was analyzed using a repeated-measures Analysis of Variance (ANOVA) test and paired T-tests. **Results:** Participants' data showed a decrease in both max-min and mean frequencies for both treatment methods, though the only statistically significant difference between baseline recordings was found in mean frequencies for meditation treatment. No significance or trend was found in changes in heart rate. **Conclusions:** We concluded that our hypothesis was not supported as the statistical tests showed a significant decrease in mean alpha wave frequencies between the baseline stressor and meditation data rather than that for music

therapy. This is indicative of meditation's greater effectiveness in increasing stress tolerance in participants, which lessened the effects of the controlled stressor event, generating lower alpha frequency waves. Upon experiment conclusion, possible sources of error were identified and varied between potential compounding effects of consecutively administered treatments and an inability of the Stroop Test (SCWT) to induce an adequate level of stress in all patients. In order to circumvent the aforementioned errors, we suggest a change in methodology in which treatments would be conducted on separate days and further research into the efficacy of the SCWT as an all-inclusive stress inducer.

Keywords

Anxiety, Stress, Neuropsychology, Adolescent, Meditation, Music

1. Introduction

Stress is a universal human experience – whether it be on a daily basis or simply an occasional disruption. Global crises, unstable economies, and technology diminishing the separation between work and home have created a modern society that demands more from individuals in all aspects of their lives. The picture of the contemporary world is clear: chronic stress affects an increasing number of healthy individuals each year. This escalating trend has fostered an increasing interest in forms of treatment to improve one's tolerance to stressful situations without having to enter a physician's office or add a new prescription. Physiologically, stress is characterized as an increase in heart rate and blood pressure, as well as a decrease in alpha-frequency brainwaves. Hans Selye, better known as "the father of stress research," was the first to apply what was once solely a term in the realm of physics to the medical field. He defined this concept as "a nonspecific response of the body to any demand" [1]. *Stressors*, such as one's work and personal life becoming increasingly demanding, leave an individual with an internal conflict between the pressure of their environment and their own perception of their strengths and/or skills—an imbalance that generates what society recognizes as stress.

Activated when the body perceives a psychological or physiological stressor, the hypothalamus-pituitary-adrenal axis (HPA) begins a cascade of hormone release. First, Corticotropin-releasing hormone (CRH) and Arginine vasopressin (AVP) from the hypothalamus trigger the secretion of Adrenocorticotropic hormone (ACTH) from the pituitary gland. This consequently triggers the release of glucocorticoids from the adrenal cortex, which in turn create effects on metabolism and immunity. The Sympathetic-adrenal-medulla (SAM) axis, the second hormone cascade involved in stress, utilizes nerves of the peripheral sympathetic system to release Norepinephrine (NE) and the adrenal medulla to secrete Epinephrine (Epi). These two catecholamines, along with glucocorticoids

from the HPA axis, circulate the system and interact with a variety of cells to deviate physiological components from baseline values [2].

This activation of the sympathetic nervous system triggers the body to enter "fight or flight" mode. The physiological changes noted above in response to these axes lead to a number of variables that can be quantitatively measured as a record of stress. The peripheral vasculature exhibits increased blood pressure due to hormones signaling the heart to pump at an increased rate. The alpha wave (9 - 12 Hz), most associated with the brain in its "idle" state, is best correlated with mental stress in comparison to delta (0.5 - 5 Hz), etc. waves [3]. As stress increases, an electroencephalogram (EEG) can be used to evaluate neurophysiology and how the corresponding activation of alpha waves, particularly in the frontal and occipital lobes of the brain, inversely decrease in power.

Many published studies examine the relationship between physiological trends, including heart rate and brain waves, and their correlation with anxiety and clinical treatment options. However, there is a lack of information for the general public about courses of action to follow in order to reduce such anxiety without pursuing clinical treatment. The following study is a cross-examination of the efficacy of three different self-regulatory treatment options that can be performed outside of a clinical setting. The combined evaluation of cardiac (heart rate) and EEG trends (alpha-frequency) will offer increased accuracy and reliability of the study's determinations, as will it show the synergism of these two biological systems when being influenced by mental stress. We assessed quantitative measures of stress levels in 10 participants during a simulated stressor event after undergoing 2 different forms of therapeutic techniques – meditation and music. This objective study aimed to evaluate the benefits of self-regulatory strategies and their ability to improve stress tolerance. We hypothesized that music would have the greatest effect on improving an individual's tolerance to the stimulated stressor event. This result will appear as the greatest deviation from the control stressor recordings (no treatment, with stress test).

2. Methodology

Participants were recruited from the Baylor University campus in Waco, Texas. We assessed 10 college students (4 male, 6 female) with an age range of 19 - 23 (median age: 21). Each individual completed a pre-data screening questionnaire to collect information such as major and age, time since last meal, evaluation for chronic stress levels, etc. This questionnaire also screens for symptoms of abnormal cortisol levels which can serve as a biomarker for chronic stress conditions [4].

An EEG recording module and snap leads from iWorx technology systems will be used to collect left and right alpha frequency waves throughout the duration of data collection. A ZacVRate finger pulse oximeter will assess changes in heart rate by comparing the final and initial measurements. Leads are to be connected to the band according to **Figure 1** seen below with conductive gel placed

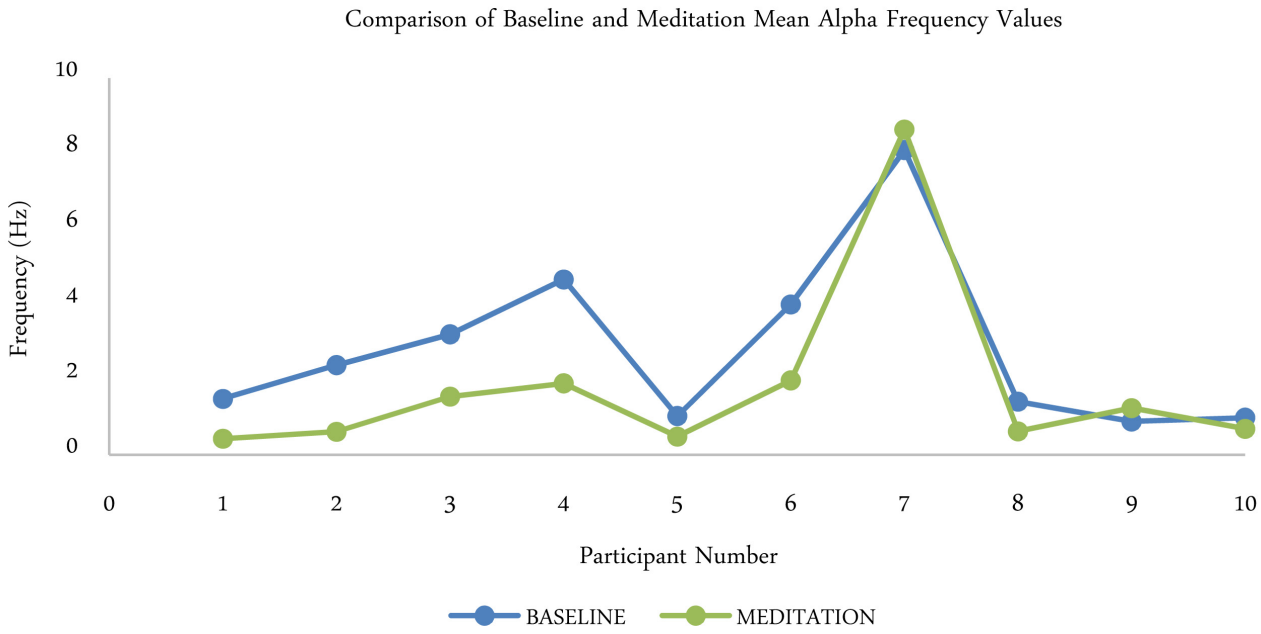

Figure 1. Mean alpha frequency values of subjects (N = 10) during baseline and post-meditation stress scenarios depict a significant decrease in post-stressor data collection.

onto the forehead where skin will make contact with the lead heads. Baseline measurements were obtained by the participant by completing a Stroop Color-Word Test (STW) before involving courses of treatment. This is a reliable laboratory stress model that has been proven to be efficient as a standard, objective, and repeatable method for inducing stress in an experimental participant [5]. While the participant verbally completes the STW cards by announcing the color of the word shown, frequency data and heart rate values will continue to be recorded. The EEG Analysis Module, in iWorx's LabScribe software package, will then be used to visualize EEG data and analyze alpha-frequency data using formulas "Max-Min" and "Mean" over thirty-second data intervals without artifact.

2.1. Treatment 1: Mindfulness Meditation

Following the completion of baseline data collection, the participant was instructed to watch a preselected guided meditation video. The 10-minute meditation is created by mindfulness instructor and Canadian author Tamara Levitt [6]. Individuals wore a blindfold and Beats over-ear noise-canceling headphones to create a controlled, distraction-free environment. The volume was set to 70 decibels. Upon the video's completion, data collection began using the same Stroop Test methodology as noted above to create a simulated stressor event. Beginning and end heart rate as well as left and right alpha-frequency "Max-Min" and "Mean" measurements were recorded in their respective data tables.

2.2. Treatment 2: Music—"Weightless" by Marconi Union

The second treatment option involved each participant listening to a track titled

"Weightless" by Marconi Union for an eight-minute duration. This ambient instrumental track was commissioned by Radox Spa under the guidance of Lyz Cooper, a professional sound practitioner. It has a tempo of 71 bpm and was presented to listeners using over-ear noise-canceling headphones at 70 decibels. Upon the song's completion, the same Stroop Test procedure as described above was conducted to induce and subsequently analyze our stress indicators of interest.

A repeated measures Analysis of Variance (ANOVA) test was used to determine the presence of a statistical difference between each of our two treatment options—music and meditation—and baseline stress values. This statistical test was carried out for each of the quantitative variables of interest, which included heart rate (bpm), "Max-Min" and "Mean" alpha wave frequency (Hz). If no statistical significance is found, t-tests were then applied to the Bonferroni Correction, where the corrected p-value equals α/n (α = original p-value, n = number of tests performed).

3. Results

The experimental data were used to contrast baseline measurements to that of both treatment options, meditation and music. Upon analyzing the quantitative variables, an overall decrease in alpha wave frequency max-min and mean values were seen for both meditation (Treatment 1) and music (Treatment 2) when compared to baseline stressor values. A greater decrease in the average max-min of frequencies was seen in treatment 2, and a greater decrease in the average mean was seen in treatment 1. Results showed that a statistically significant difference between mean alpha wave frequencies for meditation was found when compared to baseline. Though the data for music treatment was not found to be statistically significant, trends in the data suggested that there was a decrease in perceived stress following the treatment.

As depicted in **Figure 1**, there was a noticeable decrease in mean alpha wave frequency values post-meditation treatment when compared to baseline stressor values. The average mean frequency for meditation was 1.8769, far lower than the baseline mean frequency of 2.8114. **Figure 2** allows for a visual comparison of both treatment options compared to baseline values. Here, the trends across all ten participants can be seen and cross-examined.

Trends also showed a greater decrease in alpha wave frequencies from the right side of the cortex during both treatments, though this data was not found to be statistically significant.

The change in heart rate values before and after the stressor event for both treatments had no significant relationship or trend when compared to baseline.

Repeated Measures Analysis of Variance (ANOVA) tests were completed for mean and max-min outputs after averaging left and right hemisphere values. This allowed both treatment options to be compared to baseline in order to draw statistical conclusions. Upon completion of both tests, the initial p-values were

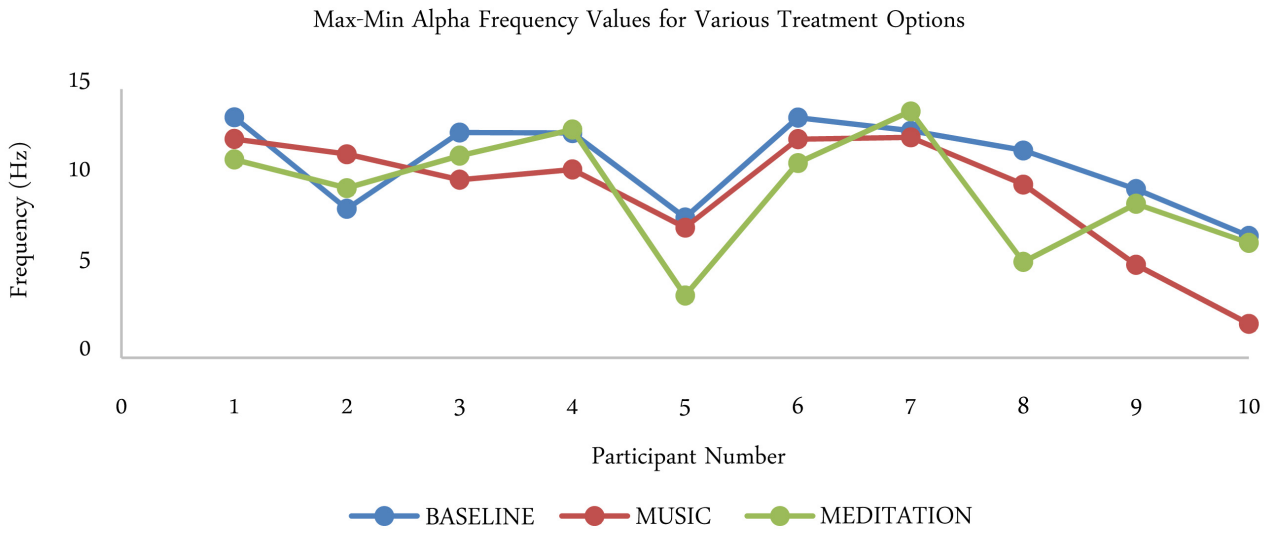

Figure 2. The average max-min alpha wave frequency of each subject (N = 10) during stressor and post-stressor after treatment. A graphical comparison of max-min frequencies for baseline stressor and each treatment. The data points for music (Treatment 1, Orange) can be observed to be generally lower than the other two variables.

found to be greater than 0.05, rendering them insignificant. Paired t-Tests were then completed to compare each variable to one another. During these post-hoc corrections, a unique statistical difference was discovered.

Data analysis allowed us to deduce that there was a significant difference in mean alpha-frequency values between baseline stress and post-meditation stress values.

By comparing the p-value of 0.0471 to the significance level of 0.05, we were able to determine the existence of a significant numerical difference between these two variables.

4. Discussion

Our hypothesis was not supported as post-meditation data had significantly different mean alpha-frequency values compared to baseline stress. Though the observed numerical decrease in the average music (treatment 2) max-min was lower than baseline recordings, the statistical tests completed upon data analysis found this to be an insignificant difference.

The comparison of these two treatment options during statistical analysis shows that meditation has a greater capability of increasing stress tolerance in college individuals. With a greater degree of stress tolerance, the participants were affected less by the controlled stressor event and generated lower alpha frequency measurements as a result. Though there has yet to be extensive research published regarding distress tolerance, its correlation with vulnerability or resilience to stressful environments is recognized by the scientific community [7]. The relationship between stress tolerance and psychopathological symptoms is becoming increasingly documented and is a point of focus for researchers and practitioners alike.

After a comprehensive evaluation, we have deduced various sources of error that could have arisen during the course of the experiment. One points to the possible compounding effects of treatment results when conducted consecutively. To counteract this, a potential change to experimental methodology could require participants to wait a certain amount of time between treatment sessions or to conduct them on separate days. Conducting treatments on separate days would require baseline stress values to be recorded for each session of data collection. An additional potential error source relates to the efficacy of the Stroop Test in inducing an adequate level of stress in each patient. Extensive research has noted this to be a useful stress scenario; however, results may differ in patients due to one's individual stress tolerance, subjective experiences, or distinctive conditions [8]. During data analysis, we discovered many outliers in male participant #1's data. This deviation from trends seen across other participants could be attributed to his condition of color blindness, which was noted during participant intake procedures. Differences in the individual's color discriminatory abilities could have a negative effect on Stroop Test performance, therefore, obscuring the true effects of each treatment on stress tolerance levels [9]. Instances as such may render the Stroop Test a less universal stress simulator than existing research may have suggested. For an additional experiment, further research should be conducted to evaluate the test's capacity to be a stress inducer that is inclusive of all potential participants.

This research has the ability to show physicians and patients alike reliable options to reduce stress in college students in a non-clinical setting. However, not only are these stress combating measures only applicable and beneficial to college students, but they are applicable to older individuals as well. The most common class of mental disorders in adult patients are anxiety disorders, with a 12-month prevalence rate of 24.9% [10]. Modern patients are seeking ways to treat their stress in quick, efficient ways and this experiment offers insight into which method offers the most benefit to their mental health and well-being. The physiological components of stress are well understood, but the psychological aspects are far more unclear. With that being said, many previously conducted studies have shown the effectiveness of mediation on an individual's physical and mental health. In a study consisting of 96 government administrators and staff, it was found that Transcendental Meditation (TM) was an effective technique for improving brain integration and reducing psychological distress [11]. Another study showed, by analyzing EEG and psychometrics, that a 6-week breathing-based mindfulness-based intervention (MBI) was effective in improving the emotional state of neurotic students [12]. Continued research into treatment options and their respective efficacies is imperative in order to educate the public and allow society a sense of independence when pertaining to one's mental health.

5. Conclusion

This research sought to evaluate the efficacy of various non-interventional

stress-reducing treatments, music and meditation therapies. During data collection, we evaluated trends in alpha wave frequencies during controlled stressor events pre- and post-therapy. We concluded that our hypothesis of music therapy showing the greatest decrease in stress levels was not supported as the statistical tests showed a significant decrease in mean alpha wave frequencies between the baseline stressor and meditation data, rather than that for music therapy. This is indicative of meditation's greater effectiveness in increasing stress tolerance in participants, which lessened the effects of the controlled stressor event, generating lower alpha frequency waves. Upon experiment conclusion, possible sources of error were identified and potential changes to subsequent experiments were theorized. The posed errors varied between potential compounding effects of treatments and a more consistent controlled stressor event. This research sought to provide accessible information for both physicians and patients alike about stress-reducing therapy options that are both non-pharmacological and can be implemented into one's daily life when outside of a clinical setting.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Tan, S.Y. and Yip, A. (2018) Hans Selye (1907-1982): Founder of the Stress Theory. *Singapore Medical Journal*, **59**, 170-171. https://doi.org/10.11622/smedj.2018043

[2] Paszkiel, S., Dobrakowski, P. and Łysiak, A. (2020) The Impact of Different Sounds on Stress Level in the Context of EEG, Cardiac Measures and Subjective Stress Level: A Pilot Study. *Brain Sciences*, **10**, Article ID: 728. https://doi.org/10.3390/brainsci10100728

[3] Chandra, S., Jaiswal, A.K., Singh, R., Jha, D. and Mittal, A. P. (2017) Mental Stress: Neurophysiology and its Regulation by Sudarshan Kriya Yoga. *International Journal of Yoga*, **10**, 67-72. https://doi.org/10.4103/0973-6131.205508

[4] Lee, D.Y., Kim, E. and Choi, M.H. (2015) Technical and Clinical Aspects of Cortisol as a Biochemical Marker of Chronic Stress. *Biochemistry and Molecular Biology Reports*, **48**, 209-216. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4436856/ https://doi.org/10.5483/BMBRep.2015.48.4.275

[5] Pehlivanoglu, B., Durmazlar, N. and Balkanci, D. (2005) Computer Adapted Stroop Colour-Word Conflict Test as a Laboratory Stress Model. *Erciyes Tip Dergisi*, **27**, 58-63. https://www.researchgate.net/publication/26437081_Computer_Adapted_Stroop_Colour-Word_Conflict_Test_as_a_Laboratory_Stress_Model

[6] Levitt, T. (2016). Daily Calm—10 Minute Mindfulness Meditation—Be Present.

https://www.youtube.com/watch?v=ZToicYcHIOU

[7] Leyro, T.M., Zvolensky, M.J. and Bernstein, A. (2010) Distress Tolerance and Psychopathological Symptoms and Disorders: A Review of the Empirical Literature among Adults. *Psychological Bulletin*, **136**, 576-600. https://doi.org/10.1037/a0019712

[8] Karthikeyan, P., Murugappan, M. and Yaacob, S. (2014) Analysis of Stroop Color Word Test-Based Human Stress Detection Using electrocardiography and Heart Rate Variability Signals. *Arabian Journal for Science and Engineering*, **39**, 1835-1847. https://doi.org/10.1007/s13369-013-0786-8

[9] Laeng, B., Låg, T. and Brennen, T. (2005) Reduced Stroop Interference for Opponent Colors May Be Due to Input Factors: Evidence From Individual Differences and a Neural Network Simulation. *Journal of Experimental Psychology*: *Human Perception and Performance*, **31**, 438-452. https://doi.org/10.1037/0096-1523.31.3.438

[10] Bandelow, B. and Michaelis, S. (2015) Epidemiology of Anxiety Disorders in the 21st Century. *Dialogues in Clinical Neuroscience*, **17**, 327-335. https://doi.org/10.31887/DCNS.2015.17.3/bbandelowc

[11] Travis, F., Valosek, L., Konrad, A. IV, Link, J., Salerno, J., Scheller, R. and Nidich, S. (2018) Effect of Meditation on Psychological Distress and Brain Functioning: A Randomized Controlled Study. *Brain and Cognition*, **125,** 100-105. https://doi.org/10.1016/j.bandc.2018.03.011

[12] Izhar, L.I., Babiker, A., Rizki, E.E., Lu, C.K. and Abdul Rahman, M. (2022) Emotion Self-Regulation in Neurotic Students: A Pilot Mindfulness-Based Intervention to Assess its Effectiveness through Brain Signals and Behavioral Data. *Sensors* (*Basel*, *Switzerland*), **22**, Article ID: 2703. https://doi.org/10.3390/s22072703