

Exploring Immersive Micro-Vacations and Their Efficacy on Multiple Biometric Markers and Productivity as A Novel Therapy for Short and Long Term Stress and Anxiety Management/Reduction
(Technical Paper)

Evaluation and Regulation of Therapeutic Technologies
(STS Paper)

A Thesis Prospectus Submitted to the
Faculty of the School of Engineering and Applied Science
University of Virginia • Charlottesville, Virginia
In Partial Fulfillment of the Requirements of the Degree
Bachelor of Science, School of Engineering

Zachry Martin
Fall 2019

Technical Project Team Members

Max Dodge
Bailey Biber
Raymond Huang
Sophia Xiao
Melanie Gonzalez
Amanda Sieger
Vy Tran
Liv Johnson

On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

Signature _____ Date _____

Zachry Martin

Approved _____ Date _____

Laura Barnes, Department of Systems Engineering

Approved _____ Date _____

Kent Wayland, Department of Engineering and Society

General Research Problem

How can mental health resources effectively expand?

After years of being overlooked, mental health issues have finally become more publicized and acknowledged. Although there have been a number of improvements in this area, including somewhat of a decrease in the stigma surrounding using mental health resources such as therapy and medication, there is still a significant lack of understanding about the causes, effects, and treatments for these issues. This prevents many individuals suffering from disorders such as stress, anxiety, and depression from seeking help and improving their condition. By not seeking help when the issue initially presents itself, these individuals put themselves at risk of suffering many of the potentially harmful physical side effects of long-term mental health disorders. Part of this disconnect between the individuals in need and the mental health service providers are the costs of treatment as well as the lack of extra resources beyond traditional treatments such as in-person therapy. The expansion of these supplemental resources could improve the effects of the traditional treatments while giving individuals more freedom to use resources and seek treatment at their own convenience. Many researchers are using technologies such as mobile phones, computers, and virtual reality to bridge this gap. Studies have indicated that these technologies could have a positive impact on individuals suffering from stress and anxiety both as a standalone treatment and in conjunction with traditional treatments.

Immersive Micro-Vacations and Their Efficacy on Multiple Biometric Markers and Productivity

Can virtual reality devices be used for short and long term stress and anxiety management/reduction?

This year I will be performing research on a technical group project for Even Health – a company that is focused on delivering digital tools to individuals for emotional strength training and immersive experiences to help employees cope with stress and anxiety in the workplace. This project, which is specifically related to the use of technology to bridge the gap between in-person and remote treatments, is called: “*Exploring Immersive Micro-Vacations and Their Efficacy on Multiple Biometric Markers and Productivity as A Novel Therapy for Short and Long Term Stress and Anxiety Management/Reduction.*” This is a particularly relevant topic to large employers given that recent research shows that 42% of employees report being stressed at work and those employees are correlated with 15-30% higher costs in health care (Gugger, 2017, p. 5). Given that average healthcare employee costs are about \$15,000 (Emerman, 2019) and about 157 million people work in the U.S. (DeSilver, 2019), this represents between \$2,250 to \$4,500 per employee and a total potential industry savings of over \$200 billion.

The problem we will be focused on solving is how effective Attention Restoration Theory, in the form of immersive virtual reality environments of various natural landscapes, is at reducing

individuals' stress and anxiety levels. We will try to answer this question by evaluating the psychological and physiological changes individuals experience as they undergo micro-vacations, which are 5-10-minute-long virtual reality experiences in a specialized booth, and compare these results to a control experience. The experiment will consist of two separate visits for each of the participants: one to test the effects of the virtual reality micro-vacation, and one to test the effects of the control experience. We will test these changes by measuring multiple biometric indicators of each participant such as heart rate, blood pressure, and skin conductance, as well as having them perform stress and anxiety surveys such as the Profile in Mood States (POMS). To develop a more accurate understanding of the effects of the micro-vacations, we will perform these biometric measurements and surveys multiple times during the experimental process. We will perform the first measurements when the participant initially arrives for the study, another after they complete a modified version of the Trier Social Stress Test, which is meant to induce a heightened level of stress prior to the experiment, and one after they have completed their micro-vacation or control experience. By gathering data on both experiences for each participant, we hope to gain a greater understanding of physiological and psychological changes these experiences induce.

To analyze this data, we will examine the results from our measurements and surveys and determine whether there is a difference in the stress and anxiety levels between both the three different periods of testing (prior to the stressor, after the stressor, and after the experience), as well as the two different experimental experiences (virtual reality or control), and then determine whether these differences have statistical significance. This analysis will provide insight on the magnitude of the differences in stress levels and allow us to create a detailed report with our conclusions on the effectiveness of the immersive virtual reality micro-vacations at reducing stress and anxiety. This information will be used by Even Health to evaluate their current product, make any necessary changes, and market their product to potential customers. Our hope is that this will aid in the development and improvement of virtual reality for therapeutic purposes, and in turn expand the number of resources available for those suffering from stress and anxiety and make them more accessible and convenient.

Evaluation and Regulation of Therapeutic Technologies

How are the emerging technologies for stress and anxiety treatment being evaluated and regulated?

Introduction

Recently, researchers have begun to test and implement new technology for treating stress and anxiety. These technologies include digital therapies accessible through the internet, mental health apps for smartphones, and virtual reality experiences of natural landscapes (Repetto et al., 2013). There has been limited research into the effectiveness of these technologies, but the research that has been done has indicated positive results. Although these technologies hold

promise, they do not seem to have been evaluated in a standardized manner across studies. After examining many sources of literature, I have noticed that many studies use a unique combination of specific biometric indicators such as heart rate, blood pressure, skin conductance, EEG/ECG, and cortisol levels, as well as surveys such as the Profile of Mood States (POMS), Perceived Restorativeness Scale (PRS), and Positive and Negative Affect Schedule (PANAS) to evaluate the effectiveness of the various technologies at reducing stress and anxiety. This does not completely discount the results of these studies, but due to the delicate nature of mental health treatment, it would be extremely useful to understand the current industry standards that each of the technologies should be evaluated against if they are widely implemented, and the regulations they will have to follow.

Background and Theoretical Framework

Due to the general public's acceptance and understanding of the merits of traditional treatments for stress and anxiety, these treatments have usually involved relatively few significant relationships outside of those between the patients and therapists. However, technology adds new relationships and increases the importance and complexity of some of the prior relationships. This can be partially attributed to the introduction of new systems of society and technology, which calls for consideration of new groups such as the researchers and developers of the technologies. It can also be attributed to the untested nature of the treatments, which makes some bureaucratic institutions such as government agencies, companies, and university administrations more active participants in these relationships as means of regulation, proper vetting, and effective implementation.

The consequences of failing to analyze these technologies before they become more popular could be potentially damaging for all of groups and their respective relationships – specifically, for both the patients, who could be receiving ineffective treatment, and for the therapists, whose profession could be unintentionally harmed by an influx of technology, which would be extremely detrimental to the quality of mental health services in general. These standards for evaluation or lack thereof could also impact other groups such as the administrators at universities and companies who have to choose whether to use the technologies or not and to what extent they should be substituted or added on the traditional treatments. Researchers and developers of the technologies are also affected by these standards, as they would need to design and test their products to be compliant with relevant regulations, most likely coming from government agencies.

Evidence/Data Collection and Methods

To facilitate this research, I plan on finding the government agencies that are tasked with creating policy on mental health treatments and examining both the measures they have taken to develop a standardized evaluation process for new technologies, as well as any regulations they have implemented in this area. After an initial examination of the literature in this area, I have found that the U.S. Food and Drug Administration has acknowledged the new technological

development in the area of mental health treatment, begun to promote it, and also reiterated that they have the public health responsibility to oversee the effectiveness and safety of these new medical devices (“Device Software Functions and Mobile Medical Applications”, 2019). They have also worked to create a pilot program called the “Digital Health Software Precertification (Pre-Cert) Program,” that will help inform development of a future regulatory model that will provide more streamlined and efficient regulatory oversight of software-based medical devices (“Digital Health Software Precertification (Pre-Cert) Program”, 2019).

I also plan on assembling a set of studies that have been performed on some of the new technologies that are specifically designed for reducing stress and anxiety. I will then record the ways the researchers and developers chose to evaluate these technologies, including any surveys, tests, or biometric indicator measurements that were used to measure efficacy and safety. I have spent a significant amount of time researching these types of studies both for my Technical Project and for my STS Research Project. So far, I have been able to compile a small list of relevant literature that includes studies such as “Virtual Reality Experience as a Stress Recovery Solution in Workplace,” which evaluated the effect of virtual reality experiences by measuring participants heart rate, blood pressure, and skin conductance, as well as by having them fill out pre- and post-experience questionnaires to quantify stress levels (Ahmaniemi, Lindholm, Muller, & Taipalus, 2017).

To provide more comprehensive details on the current state of the use of mental health technologies, I plan on finding examples of the implementation of one or more of these technologies by universities or other education providers, as well as businesses or other large employers, and examining the results of these implementations to determine what measures they used to choose technologies. I initially researched UVA, and after examining the website that outlines the mental health services that the university offers to students, I understand that UVA has implemented a digital online service called SilverCloud that they offer to students as a way to improve mental health conditions (Counseling & Psychological Services (CAPS), n.d.). To begin my research in this area, I plan on inquiring into how UVA chose this particular software by contacting relevant individuals inside the CAPS program via email and in-person or over-the-phone interviews.

Using a combination of these sources of information, I will develop insight into what standard evaluation policy is currently being used to regulate these technologies. I will also analyze the current level of adherence to these standards by both the individuals researching and designing them, as well as the groups implementing them, by comparing the criteria for evaluation that these groups have used in their processes against the standards of evaluation laid out by the government agencies involved in mental health technology regulation.

Conclusion

Mental health treatments have expanded and improved over time, but with the development of new technologies to bridge the gap between in-person and remote treatment, there is a need for a

thorough inquiry into how these technologies are evaluated by the various groups involved in these processes. Ideally the information I compile and analyze during my STS Research Project will provide a greater understanding of how these mental health technologies are being tested and evaluated at multiple levels and by multiple groups. It will also indicate the success of the regulation in influencing the products that individuals and groups decide to use. This information should be especially useful to individuals who are seeking treatment and are interested in learning more about technologies that are available, and how the efficacy and safety of these technologies are measured. It could also be useful to the groups involved in the evaluation process, because it will provide a comprehensive insight into the level of collaboration and cohesion that is currently occurring between the groups. By providing this resource, I can inform relevant groups about the current state of the evaluation and regulation processes, which could lead to improvements in their structure and implementation. My hope is that this results in an improvement of the quality of care that people who are suffering from mental health disorders such as stress and anxiety are able to receive.

References

- Ahmaniemi, T., Lindholm, H., Muller, K., & Taipalus, T. (2017). Virtual reality experience as a stress recovery solution in workplace. *2017 IEEE Life Sciences Conference (LSC)*. doi: 10.1109/lsc.2017.8268179
- Counseling & Psychological Services (CAPS). (n.d.). Retrieved from <https://www.studenthealth.virginia.edu/caps>.
- DeSilver, D. (2019, August 29). 10 facts about American workers. Retrieved from <https://www.pewresearch.org/fact-tank/2019/08/29/facts-about-american-workers/>.
- Device Software Functions and Mobile Medical Applications. (2019, September 26). Retrieved from <https://www.fda.gov/medical-devices/digital-health/device-software-functions-including-mobile-medical-applications>.
- Digital Health Software Precertification (Pre-Cert) Program. (2019, July 18). Retrieved from <https://www.fda.gov/medical-devices/digital-health/digital-health-software-precertification-pre-cert-program>.
- Emerman, E. (2019, August 13). Business Group Press Release. Retrieved from <https://www.businessgrouphealth.org/news/nbgh-news/press-releases/press-release-details/?ID=361>.
- Farrer, L., Gulliver, A., Chan, J. K., Batterham, P. J., Reynolds, J., Callear, A., ... Griffiths, K. M. (2013). Technology-Based Interventions for Mental Health in Tertiary Students: Systematic Review. *Journal of Medical Internet Research*, *15*(5), e101. <https://doi.org/10.2196/jmir.2639>
- Gugger, E. (2017). Quantifying the impact of stress on your employee population's health. IBM Watson Health, 1–8. Retrieved from <https://www.ibm.com/downloads/cas/QNBKLGOE>
- Kessler, R. C., & Greenberg, P. E. (2002). The Economic Burden of Anxiety and Stress Disorders. In *Neuropsychopharmacology: The Fifth Generation of Progress* (pp. 981–992). American College of Neuropsychopharmacology.
- Loo Gee, B., Griffiths, K. M., & Gulliver, A. (2016). Effectiveness of mobile technologies delivering Ecological Momentary Interventions for stress and anxiety: A systematic review. *Journal of the American Medical Informatics Association*, *23*(1), 221–229. <https://doi.org/10.1093/jamia/ocv043>
- Repetto, C., Gaggioli, A., Pallavicini, F., Cipresso, P., Raspelli, S., & Riva, G. (2013). Virtual reality and mobile phones in the treatment of generalized anxiety disorders: A phase-2 clinical trial. *Personal and Ubiquitous Computing*, *17*(2), 253–260. <https://doi.org/10.1007/s00779-011-0467-0>