

USING VIRTUAL REALITY MEDITATION TO REDUCE
LEVELS OF ANXIETY IN WOMEN ON ORAL CONTRACEPTIVE
BIRTH CONTROL

By
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A Thesis Submitted to The W.A. Franke Honors College

In Partial Fulfillment of the Bachelor's degree
With Honors in

Physiology

THE UNIVERSITY OF ARIZONA

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Abstract

Twenty percent of women aged 18-39 who currently use oral contraceptive birth control report noted levels of increased anxiety since beginning use of the medication. There is a multitude of integrative medicine practices such as acupuncture, yoga, meditation, and dietary supplements that can ease symptoms of anxiety and stress which can be adopted into everyday life as an alternative to additional medication to manage anxiety. The use of innovative technology such as virtual reality allows some of these methods to become more accessible to a wider range of individuals and tailored to ways that are most beneficial to the individual. The Oculus 2 is a virtual reality (VR) device that allows users to download applications and immerse themselves in different meditation, fitness, and yoga virtual environments. In this preliminary study the meditation app, Maloka, was trialed to assess whether virtual reality can be used to ease feelings of anxiety with a focus on helping women with oral contraceptive birth control. There have been previous studies that have seen a strong correlation between low anxiety levels following the use of multiple head-mounted displays (HMD) virtual reality apps. The autonomic nervous system (ANS) is a key player in responding to and regulating levels of stress and anxiety in the body. The Andrew Weil Center for Integrative Medicine is currently researching sweat pore activity (SPA) using thermal imaging as a real-time measure of ANS activity in response to different stimuli. For this current study, a pool of 10 women completed a Qualtrics online survey inquiring about their perceived anxiety while taking oral contraceptive birth control and if they practiced any integrative medicine methods/techniques to reduce their perceived stress. The results of this survey showed that women on oral contraceptive birth control have subjectively more anxiety than when not on any medication. The use of a BIOPAC and Thermal IR camera was used to collect data for SPA, skin conductance response (SCR) and

heart rate variability (HRV) under the three types of stimuli 1) non-virtual integrative medicine techniques such as 4-7-8 breathing, a relaxation method developed by Dr. Andrew Weil 2) a Jump Scare VR video, and 3) a virtual meditation app via the Oculus. Originally this study was supposed to take place with a participant amount of 30 women on oral contraceptive birth control though due to COVID-19, it was instead beta tested with one participant who is currently on oral contraceptive birth control to see if her levels of anxiety were lessened using virtual reality methods. The results were supportive of the fact that an Oculus or other virtual reality device may have a positive impact and should be integrated into the daily lives of other people with anxiety disorders. There were steady levels overall of heart rate and lower levels of active sweat pores when the participant underwent meditation via the Maloka app on the Oculus. The goal of this study was to show that there should be more research and further experimentation to investigate virtual reality applications more comprehensively as a way to for not only anxiety disorder but all types of mental health struggles.

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Acronyms

VR: virtual reality

HMD: head-mounted display

ANS: autonomic nervous system

SPA: sweat pore activation

HRV: heart rate variability

SCR: skin conductance response

GAD: Generalized Anxiety Disorder

BAI: Beck Anxiety Inventory

HADS-A: Hospital Anxiety and Depression Scale-Anxiety

STAI: State-Trait Anxiety Inventory

DSM-5: Diagnostic and Statistical Manual of Mental Disorders 5th edition

ECG: electrocardiogram

EDA: electrodermal activity

MBSR: mindfulness-based stress reduction

AWCIM: Andrew Weil Center for Integrative Medicine

SC3: stress challenge/stress correlation/sweat collection

Introduction

Prevalence of oral contraceptive birth control use

The motivational aspect of this study is the use of oral contraceptive birth control and how this affects the levels of anxiety in women who are currently taking it. Oral contraceptive birth control has become increasingly popular in women between the ages of 15-and 44 years old for a multitude of reasons including pregnancy prevention, menstrual pain, and acne treatment (1). However, many of these women are unaware of certain side effects such as higher rates of depression, anxiety, and neurotic symptoms. Within a compilation of seven studies, it was found that women who were not users of hormonal oral contraceptives did not experience the same rate of anxiety and depression as women who were currently taking such contraceptives (2). Many oral contraceptive labels do not even include increased feelings of anxiety or worry as established side effects, making it not a normal screening question when looking for contraindications in prescribing the medication (3). Hormones are a huge factor in emotional responses within the body, birth control works to block the normal rhythm of hormone cycles to prevent pregnancy. In a normal menstrual cycle, there is a gradual climb to a peak around the 14-day mark of a 28-day cycle giving the body ample time to adjust to hormone changes and compensate for mood swings. Most birth control pills work to flatten this curve altogether that instead is a very flat line leading up to day 21 of the cycle when estrogen and progesterone, two major female hormones responsible for reproduction and menstruation, drop dramatically (4). It would make sense that this would physiologically cause the body to enter a stress state as the normal hormone levels have been decreased. Due to the lack of experimental evidence behind the relationship between increased anxiety and women on birth control, this study was initially curated to analyze the anxiety levels of women on birth control to see if their HRV, SCR, and SPA area of abnormal levels and to pinpoint to levels of anxiety.

The goal of this study

The goal of the study is to show that anxiety can be seen physiologically using the systems of BIOPAC and IR camera as well as that virtual reality can have a beneficial impact on anxious feelings and become a device that can be used therapeutically. This all allows a basis for future research into the perceived elevated levels of anxiety in women on oral contraceptive birth control and how anxiety symptoms can be combated with the adoption of integrative medicine techniques into a daily routine. Integrative medicine techniques commonly performed to combat symptoms of anxiety are acupuncture, dietary supplementation, yoga, and meditation.

Acupuncture helps the body heal itself in a non-invasive way by using needles to stimulate the central nervous system. It has been noted to benefit those who struggle from both emotional and physical illnesses such as anxiety and stress (5). Dietary supplementation works to keep the body nutritionally balanced to help make sure there are no imbalances that could hinder the effectiveness of the central nervous system. Yoga aids in relieving stress and promoting better health habits such as sleep and exercise. In addition, meditation goes hand in hand with yoga as they both improve symptoms of anxiety and depression as well as improve overall mental health. Meditation reduces blood pressure, overall promoting better health by keeping the body at a baseline (6). The Oculus virtual reality systems were used to analyze the benefits of integrative medicine on the autonomic nervous system on a different platform. As a society, we have run into a new era of mental health awareness, and conducting this experiment can be used as more support that there need to be mental screenings before women begin the use of birth control. It has been previously noted that certain birth controls have side effects such as developing anxiety and depression, but this is not always advertised. An assessment of psychological well-being and

its impact on sexual and reproductive health functioning should be a routine component of the patient interview to avoid potential side effects such as anxiety that can be detrimental to some.

Background

Generalized anxiety disorder

People may feel anxious when presented with situations that cause stress such as a test, relationship problems, or a copious workload. The type of anxiety being analyzed in this preliminary study is a form of diagnosed anxiety called Generalized Anxiety Disorder (GAD) and its prevalence specifically in women who take oral birth control. This disorder is defined as a feeling of excessive worry or anxiety lasting most of the days over six months. GAD may affect many aspects of someone's life such as participating in work, and social events, and can even diminish their overall health. Signs and symptoms of GAD include irritability, difficulty controlling feelings of worry, restlessness, difficulty concentrating, and fatigue (6). The current assessment used to diagnose anxiety is the Diagnostic and Statistical Manual of Mental Disorders- 5th edition, DSM-5, which is used to measure one's risk for anxiety and outlines the criteria for GAD over other subtypes (7). It is important to note that this manual is not used to guide treatments but strictly to provide a baseline for diagnosis of mental health disorders. There are three commonly used tests to differentiate between specific anxiety measures. The first is the Beck Anxiety Inventory (BAI) commonly used to separate symptoms between depression and anxiety as they sometimes overlap. Second, there is a test used in a more clinical environment called the Hospital Anxiety and Depression Scale-Anxiety (HADS-A), often used in medically ill patients to assess their symptoms of anxiety and fear clinically. Lastly, the State-Trait Anxiety Inventory (STAI) is used for self-assessment of one's anxiety symptoms at that moment in time

and in general. STAI is a 40-item self-reported scale that will analyze the severity of one's anxiety symptoms. The first 20 items are based on how anxious the person felt over the past seven days, to consider that there are other factors in life that can cause short-term anxiety. The second 20 items analyze more anxiety personality traits that are commonly associated with people who have high anxiety. The combination of the two sets of questions collects crucial information for the analysis of anxiety disorder, the "State" subscale is used to detect a longitudinal change in a person, while the "Trait" subscale is used to identify anxiety as a fixed characteristic (8). STAI scoring is on a 0-63 scale with the defining groups being: 0-9 indicates normal or no anxiety; 10-18 is associated with mild to moderate anxiety; 19-29 guides moderate to severe anxiety; and 30-63 documents severe anxiety.

Data collected

This study is designed to focus on individuals who scored above 19 to indicate at least mild anxiety and combine this score with physiological measures such as HRV, SCR, and SPA to provide both psychological and physiological evidence of anxiety in women at birth control. Unfortunately, due to COVID restrictions, participants were unable to come into the lab for measurements, so the project was modified to provide an example of the potential of this approach. Data was pulled from one female within the Andrew Weil Center for Integrative Medicine (AWCIM) stress challenge/stress correlation/sweat collection (SC3) lab who is currently on oral contraceptive birth control to provide evidence that this study should take place in the future to analyze the effects of anxiety on women on oral contraceptive birth control. Initially, a Qualtrics survey was developed to be able to recruit the proper participants for this study but instead, it was used as evidence that women on oral contraceptive birth control have increased feelings of anxiety.

Autonomic nervous system

The ANS is a key player in the regulation of anxiety and stress. The ANS is a part of the peripheral nervous system that provides our involuntary response through the sympathetic and parasympathetic branches. More specifically the sympathetic nervous system is our “fight or flight response” which leads to a state of overactivity in our body including heart rate, blood pressure, and respiration. The sympathetic branch of the autonomic nervous system is the one responsible for triggering anxiety while the parasympathetic branch returns the body to baseline (9). In addition to an overactive heart rate, blood pressure, and breathing rate; levels of SPA and SCR were collected in times of intense stress such as when the body feels anxiety.

Sweat activity in anxiety

The ANS activates sweat glands via a specific chemical called acetylcholine as well as innervating neurons that work to activate sweat glands at the same time as the body responds to stressful situations. Commonly people who are experiencing anxiety also begin to perspire as it’s the body’s natural response, but hyperhidrosis or excessive sweating is a symptom of GAD that sometimes leads to needing treatment (10). The analysis of this sweat was conducted using one BIOPAC application called electrodermal activity, EDA to collect the skin conductance. EDA measures the rate of production of sweat in sweat glands and the BIOPAC does this by leads connected to one of the participants’ palms. In times of nervousness or stress, these levels are normally elevated. Physiologically what is happening is with a stimulus the body will trigger the autonomic system to produce and release eccrine sweat. Previous data has shown that people with GAD display a slowed return to baseline EDA levels (11), which will be compared in this study to the participant’s baseline that we collect at the beginning of the experiment. Although in general normal human EDA levels range from 1 to 20 micro siemens. The trend that should be

evident is that after the stimuli have taken affect the participant's skin conductance response, SCR, should remain higher and take a long time to return to baseline. Additionally, a Thermal IR camera was used to monitor sweat pore activation. This camera is a non-invasive technique used to measure changes in the body's thermal activity and enables measures of perspiration (12). The Thermal IR camera was used to analyze sweat pores on the inside of participants' feet which should increase in temperature during times of stress.

Heart rate activity in anxiety

The electrocardiogram, ECG, provides an electrical measurement of heartbeats using an arrangement of three leads attached to the participant's left and right upper chest as well as one just below the rib cage. The ECG data collected will be classified as HRV at both states of arousal and rest. Heart rate variability is a measure of the autonomic nervous system's health and is the variation analyzed and interpreted by the calculated low inter-beat interval (IBI). Anxiety disorder is associated with an impaired function of the cardiovascular system meaning also altered ability of HRV, specifically a chronically low level of HRV at a resting state due to a diminished ability to activate the ANS (13). During times of stress stimuli, the HRV should be of a lower value than someone without GAD, though HRV overall does decrease when the ANS is presented with a stressor. In an outside study, this was confirmed when anxious individuals were compared to non-anxious individuals at a baseline resting period before a stressor (13).

Secondly, during the period of meditation, the HRV should remain relatively steady compared to the stress response.

Oculus virtual reality

Lastly, the Oculus virtual reality system was used to stimulate the autonomic system. Oculus creates a 3-D world that allows users to interact and explore with incorporated surround sound fully immersing the user into a new simulation both mentally and physically. There is a multitude of applications available on this device such as meditation applications as well as other mentally stimulating videos to trigger the nervous system. Initially, stress was put on participants through a jump scare activity that was expected to trigger the sympathetic nervous system then the participant was introduced to a calming meditation application to see if integrative medicine techniques have the potential to ease symptoms of anxiety. Virtual reality has the potential to be used in the medical world for training, treatment, and learning. Specifically, virtual reality can be an additional diagnosis and treatment for anxiety disorders through this repetitive exposure therapy to fear stimuli (14). There is new upcoming research into the use of virtual reality systems for a multitude of mental disorders including anxiety and recently there has been a strong correlation between lower levels of anxiety when presented with positive stimuli in virtual reality (15). In this lab, the focus is on the integrative medicine technique of meditation to see if it can help lower levels of anxiety which will be supported or rejected via measurements from the BIOPAC and Thermal camera. Meditation is used for the treatment of GAD via mindfulness meditation which is a form of mindfulness-based stress reduction therapy (MBSR) and focuses on learning to detach from anxious thoughts (16). There has already been a great reduction seen in anxiety and greater positive self-talk with the use of MBSR so it is important to see if related results can be produced using a virtual reality platform.

Methods

Participants

Participation in the study was voluntary with the main inclusion criteria as follows: 1) a female currently on oral contraceptive birth control, 2) between the ages of 18-28, and 3) who can come into the lab for completion of the experimental protocol in-person. Oral contraceptive birth control women are used in 25% of women aged 15-44 as a first-line method to avoid pregnancy (1), meaning there is a large pool of potential participants available to participate if willing. Interested participants would have found a QR code on posted recruitment flyers distributed through undergraduate physiology or psychology list services. An online survey service, called Qualtrics provided by the University of Arizona, was created to determine potential participants' eligibility for the study. It instead was used to establish, by 10 outside participants who met the criteria, that there is a population of women on oral contraceptive birth control who have noted increased levels of perceived anxiety since beginning the use of oral contraceptive birth control. Study participation exclusion criteria include women on anxiety medication, men, and people unable to make it to the lab. A recruitment enrollment of 30 participants was targeted to complete a secondary survey and in-lab portion of the study, though due to COVID restrictions the in-lab portion of this study was unable to be collected with this number of participants. Instead, this experiment was beta-tested using one current female lab collaborator who is currently on oral contraceptive birth control.

Study Design and Procedures

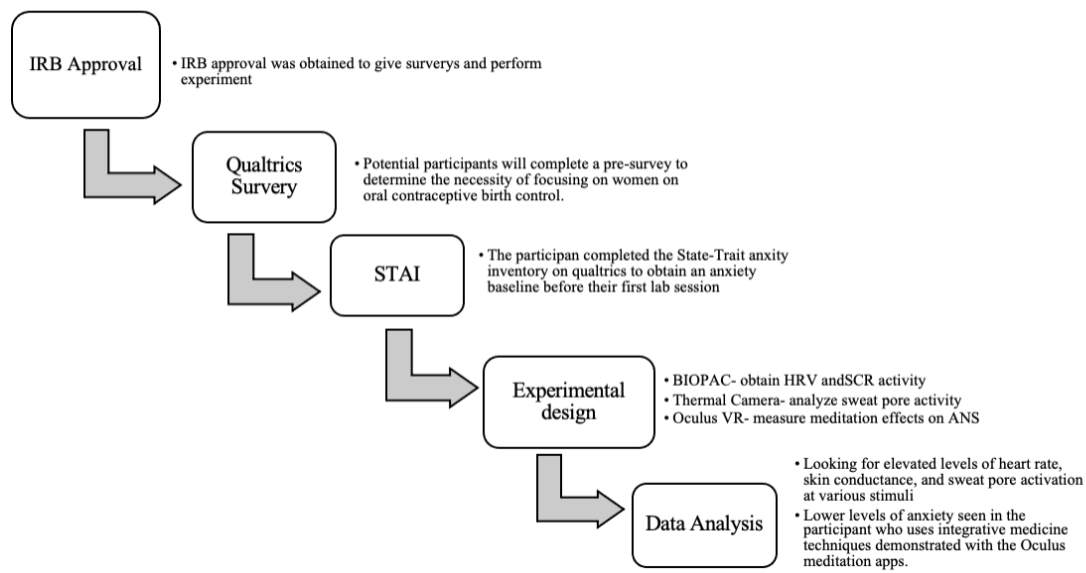


Figure 1: Outline of the study design and procedures

This preliminary study used both psychological and physiological measurements to form an observational study that looks to find the correlation between anxiety and the use of oral contraceptive birth control in women. The psychological measurement was collected through the STAI survey which would have measured a baseline of the participant's anxiety levels on the day of the actual lab as well as measured scores over a longer period. Physiological measurements were collected using the BIOPAC machine and Thermal imaging camera. The participant was attached to the BIOPAC machine for measurements of their ECG and subsequent calculation of HRV and IBI, and SCR via EDA. At the same time, their right foot was placed in front of a thermal IR camera to provide imaging of their active sweat pores. To obtain measurements, the participant completed two portions of stimulation, first without the use of virtual reality devices, and then the Oculus was integrated to simulate realistic nature settings. To begin the non-virtual portion, the participant was asked to maintain normal breathing for one minute to get a baseline,

then complete a round of Valsalva's for 30 seconds, after which they took another 30-second regular breathing break before doing the 4-7-8 breathing technique for 3 cycles. As stated previously, anxiety can cause an increase in heart rate and blood pressure which is being mimicked in this lab test via Valsalva. This maneuver triggers both the sympathetic and parasympathetic nervous systems as it is creating stress on the body and the body must respond to this stress. The initial inhale contracts both the abdomen and thoracic muscles causing a sudden increase in intrathoracic pressure and an initial decrease in heart rate (17). This does not last long as the heart tries to compensate for the lack of oxygen, cardiac output, and the amount of blood being pumped per minute starts to decrease causing the intrathoracic pressure to also decrease, which increases the heart rate. The low intra-thoracic pressure and increase in heart rate are what stimulate the sympathetic nervous system. Once a breath is taken, the parasympathetic nervous system is activated via the vagus nerve, resulting in a decrease in heart rate. This technique is a good measure of the autonomic system and allows evaluation of how the body reacts when under conditions of anxiety. The breathing pattern of 4-7-8 breathing is as follows: inhale through the nose for 4 seconds, then hold for a count of 7, and lastly exhale for a count of 8. This technique activates the parasympathetic nervous system as this is used for stress suppression and works to counteract the sympathetic nervous system (18). Next, the participant completed the virtual reality portion of this lab which includes a simulation of a jump scare and meditation. A jump scare is supposed to trigger the sympathetic nervous system so there should be elevated levels of SCR and SPA. When someone is scared there is a quick flood of hormones, cortisol and adrenaline, and neurotransmitters leading to an increase in heart rate, alertness, and breathing rate (19). The jump scare was used to provoke anxiety as the time leading up to the scare is quite nerve-racking. The jump scare simulation was produced using the "Try Not To

Flinch Challenge” available on the YouTube VR app (20). Then the participant was directed to the meditation app Maloka for further analysis of the autonomic nervous system. Meditation is one of the key integrative medicine techniques for treating symptoms of anxiety with already known significant benefits in reducing anxiety from previous studies (16).

Measures and Physiological Testing

The baseline STAI score would have been crucial for determining the levels of the participants in the study before having them proceed with the physiological measure testing in the lab. The BIOPAC machine was used for HRV and EDA measures. Heart rate variability measures heartbeat activity as an electrical measurement. The ANS directly correlates with heart rate as the sympathetic branch increases its beats per minute during times of stimulation while the parasympathetic works to decrease the heart rate in times of relaxation. HRV shows any inconsistencies of the ANS by the amount of time between heartbeats. EDA is the control of sweat gland production neurologically, especially in the areas of the hand and foot. EDA increases when someone is nervous or anxious about a stimulus or an event. This system works by looking at the autonomic response to stimulation and can be used to look at emotional expression. When there is stimulation, it will lead to increased sweat secretion from sweat glands due to the sympathetic branch activation. This study used EDA to determine the SCR of the participant at times of stimulation. To measure EDA, two electrodes must be attached to the participant on the palms of their hands and when it is running it will produce wavelengths showing peaks that should increase with sudden changes. The IR Thermal camera works to look at sweat pores and allow visualization of when they are active. When compared with SCR this measurement shows us how to sweat gland activation is another component of the ANS reaction in times of increased anxiety.

Data processing

The BIOPAC systems, Thermal IR camera, and Oculus virtual reality systems were used to look at the levels of HRV, SCR, and SPA at various stimuli to find the correlation between anxiety and elevated levels of each. BIOPAC offers two applications: electrocardiogram, ECG, electrodermal activity, EDA, which measures heart rate levels, and skin conductance activity. The ECG data were investigated using the QRS tool to collect the IBI to analyze the HRV. The SPA data was processed through MATLAB and produced an output of the number of active sweat pores shown in the video collected by the Thermal IR camera. This data was correlated with the SCR data shown in Figures 5-7 to look for similar peaks in the active number of sweat pores and electrical conductivity of the skin collected through the EDA. The SCR data had an output in micro siemens and when looking at active sweat pores, the more active pores there are, the higher the SCR should be because that means the skin is producing sweat.

Data Analysis

When looking at heart rate variability measures, someone who is showing worsening anxiety about a situation will exhibit lower levels of HRV also meaning they are in fight or flight mode (6). In the participants, there should be a lower HRV following stimulation of the ANS via Valsalva's and Jumpscare compared to their baseline HRV versus their HRV. Additionally, a steady HRV should be observed when meditating. EDA data will be collected for an investigation into the peaks allowing interpretation of the SCR to be compared to the participants' baseline. An elevated SCR amplitude seen in the EDA peaks correlates to an emotional response and a period of arousal or mental distress. In participants exhibiting anxiety, there should be larger peaks as well as a longer period where they were trying to return to

baseline after the stimulation had ended. The Thermal IR camera was used to give a live display of the number of active sweat pores of the participant.

Data storage and security

The sweat lab that supported this experiment through the Andrew Weil Center for Integrative Medicine uses REDCap to allow for security, deidentification, and sharing of data. REDCap is a program developed at Vanderbilt University and available free of charge to researchers at the University of Arizona. REDCap allows uploading and curating of raw data to a storage facility to allow one to obtain data as well as share data with potential collaborators (20). This system is important because it protects the data and is a key component for moving forward with research in the future as it allows groups to further investigate ideas that were left unfinished or would benefit from further experimentation. The data and experimental design of the study will be uploaded to REDCap with the goal that other researchers will be interested in carrying out my experiment to a fuller extent.

Results

This preliminary study has been beta-tested on one participant who met the study inclusion criteria. An outside pool of about 10 women on oral contraceptive birth control completed a Qualtrics online survey to note the elevated levels of anxiety that women have while using this type of birth control. All 10 women who filled out the survey noted increased feelings of anxiety on a day-to-day basis since beginning the use of oral contraceptive birth control. The in-lab results indicated that using the Oculus VR as a meditation tool for women with anxiety can provide benefits to reducing heart rate and sweat pore activation overall reducing the activity of the sympathetic nervous system and feelings of anxiety. These results also support the fact

that more research should be conducted to further conclude the use of Oculus VR meditation as a tool for coping with symptoms of GAD, especially in women with elevated anxiety levels due to oral contraceptive birth control. The levels of HRV collected using the ECG on the BIOPAC, shown in Figures 2, 3, and 4, exhibit lower IBI following anxiety-provoking stimulation, at the initial jump scare the IBI reached between 880-1000 IBI but then dropped very low to about 300 IBI quickly after which is below baseline levels observed in the first minute in figure 2. There was multiple jump scares in this video with the most effective one being at the 15-second mark. Overall, there was about 3 jump scares that took place in the initial 15 seconds. Compared to figures 1 and 3, whose IBI levels remained steady around 300-400 IBI. In figure 2 there is a peak at around 75 seconds which would be where the Valsalva is happening, another maneuver to stimulate the sympathetic system and mimic anxiety and this was followed by lower levels of HRV compared to baseline. Lastly in figure 4, the levels of IBI remain at a steady-state and remain below 450 meaning the sympathetic system was at rest. The figure 2 trial was used to establish levels of IBI when someone is at a known stimulation state, Valsalva, and then at a known relaxation state, 4-7-8 breathing. This trial allows us to assess the effectiveness of virtual reality for the treatment of anxiety relative to cardiovascular health.

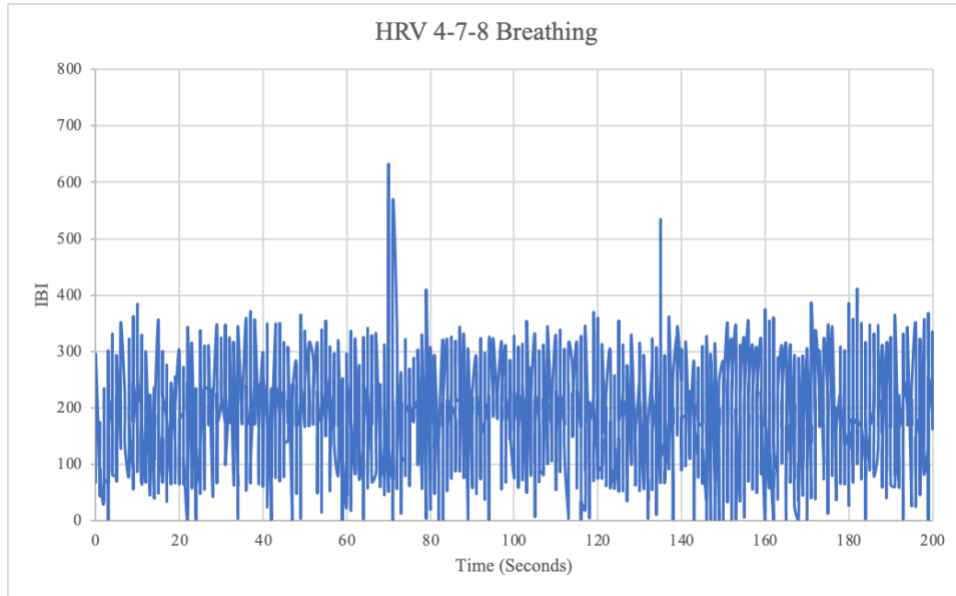


Figure 2: Heart rate variability data of the trial involving the run of one-minute normal breathing, 30 seconds of Valsalva, 30 seconds of normal breathing, 57 seconds of 4-7-8 breathing, and one-minute normal breathing.

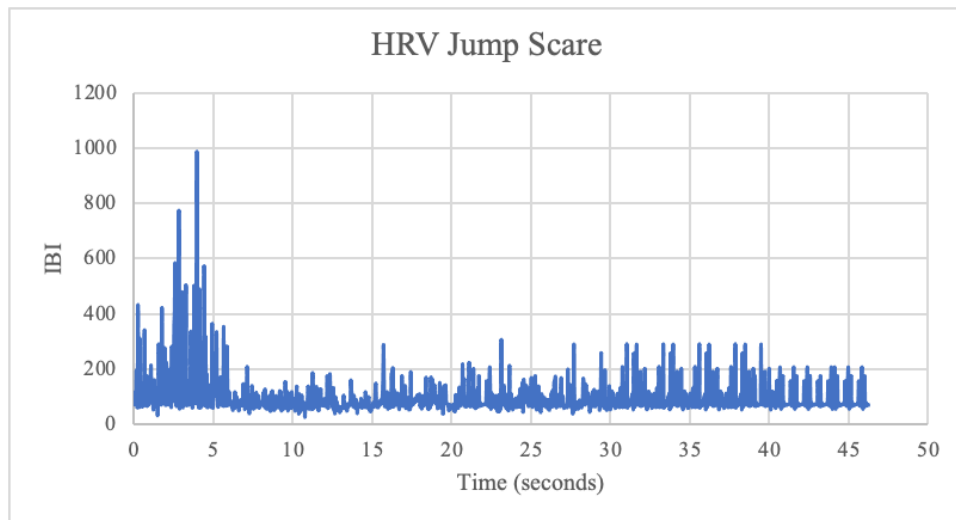


Figure 3: Heart rate variability data of a jump scare produced by watching a try not to flinch YouTube video (20).

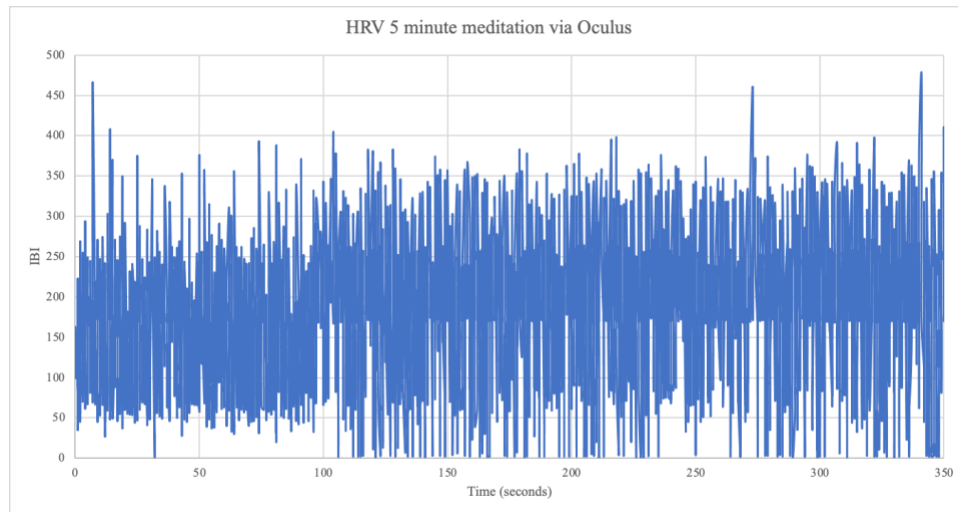


Figure 4: Heart rate variability data of the meditation setting created via Oculus VR.

In addition to the analysis of HRV, data was collected from the thermal camera showing sweat pore activation and from the BIOPAC to show skin conductance. This data supported the idea that meditation produced on Oculus VR software was effective in inactivating the sympathetic nervous system in terms of sweat activity. Initially, meditation methods were analyzed using Valsalva to stimulate the sympathetic nervous system and then the 4-7-8 breathing method to ease the stress. This data showed high sweat pore activation and SCR numbers when normal breathing and Valsalva were initiated but low levels at 4-7-8 breathing and for a minute after. This correlates to the HRV data as there is a peak in IBI at the time of Valsalva then the 4-7-8 breathing method brings the heart rate back to baseline and below. In figure 6, the number of active sweat pores jumps is related to a spike in the heart rate variability in Figure 3. The sweat pores are activated at the time of the video that the participant said they were most scared and overall, the data shows that the participant had the highest levels of sweat

pore activation during the jump scare. Lastly, in figure 7 the data shows low sweat pore activity with the lowest SCR as well. Combined with the HRV data for the meditation the participant was overall more relaxed here with the lowest IBI in addition to a stable level of data throughout the run.

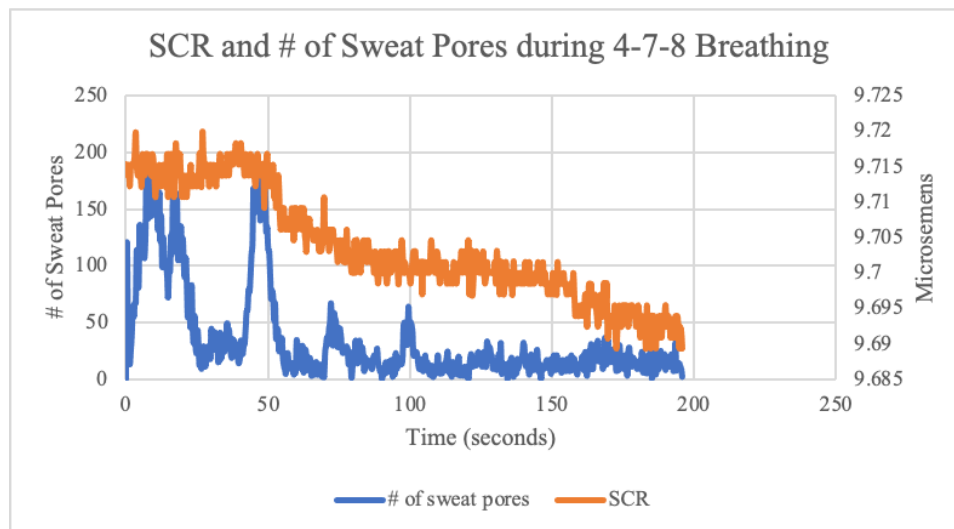


Figure 5: SCR and # of sweat pores activated during the trial focusing on using non-virtual mediation practice of 4-7-8 breathing. The trial was one-minute of normal breathing, 30 seconds of Valsalva, 30 seconds of normal breathing, 57 seconds of 4-7-8 breathing, and one minute of normal breathing.

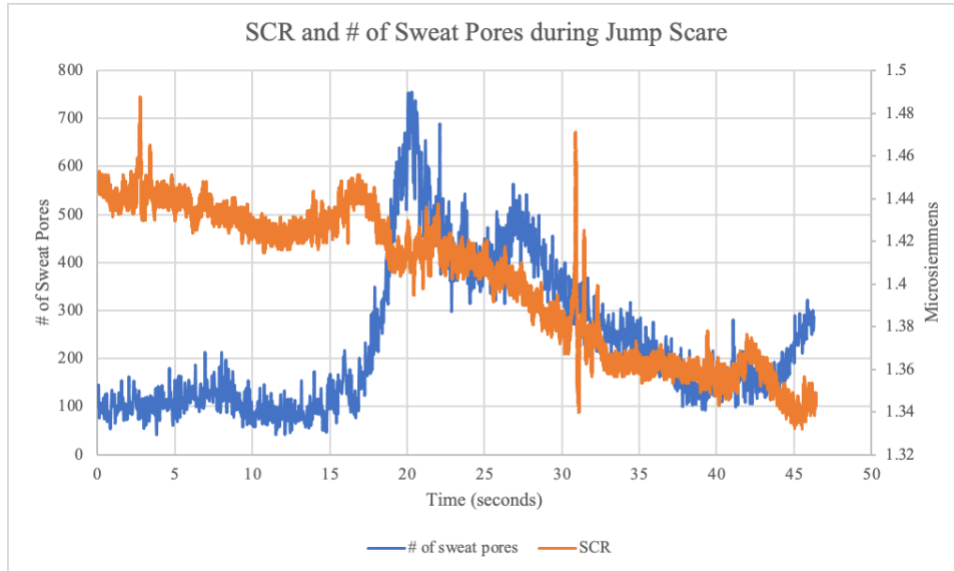


Figure 6: SCR and # of Sweat pores during jump scare stimulation. The first jump scare occurs at time 0 and there are two more jump scares in the initial 15 seconds with the most effective jump scare at the 15-second mark.

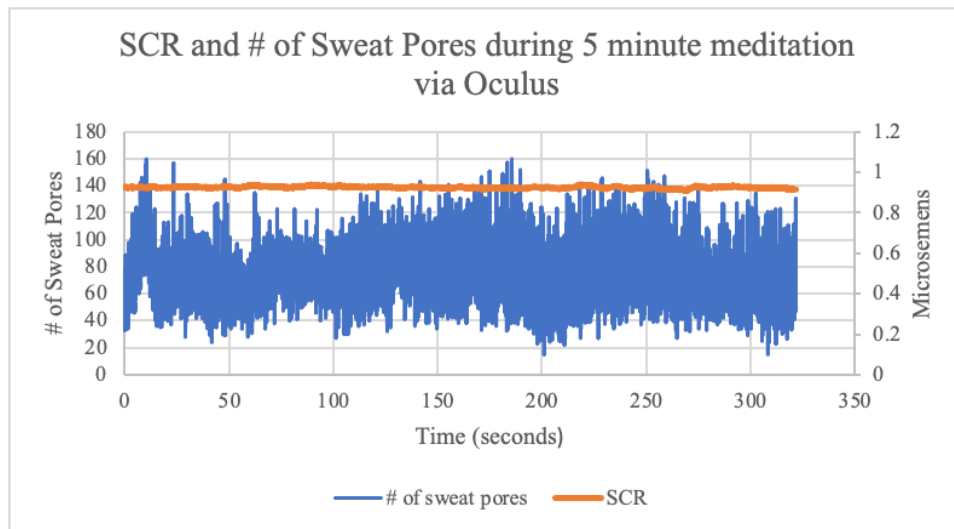


Figure 7: SCR and # of sweat pores activated during 5-minute meditation.

Discussion

Overview of the study

This preliminary study was approved by the Institutional Review Board, beta-tested, and is now ready to be further investigated with a larger pool of participants. There were a few aspects of this thesis project that were not able to be carried out to their full potential due to COVID-19 restrictions. This study was originally set to analyze the anxiety levels of 30 women between the ages of 18-28 who were currently using oral contraceptive birth control for completion of the experimental protocol in-person to see if their heart rate, skin conductance, and cortisol levels are abnormal and point to levels of anxiety. The outside laboratory portion of using Qualtrics online survey service supported those 10 women on oral contraceptive birth control subjectively have seen an increase in their perceived anxiety since beginning the use of this medication.

Evaluation of results

The proposed tests were run on one female lab collaborator on oral contraceptive birth control to provide initial support for a new method of therapy when treating anxiety. The data collected in this study via BIOPAC, and Thermal camera supported lower anxiety levels based on the physiological measurements collected when using a meditation app, Maloka, on Oculus. There were overall lower levels of active sweat pores, skin conductance, and heart rate when using the Oculus device for meditation. When compared to established methods of therapy, 4-7-8 breathing showed similar effectiveness in calming down the participant's sympathetic nervous system. As expected during periods of stress, shown through Valsalva at the 60-90 second (about 1 and a half minutes) mark in Figure 2 and during the Jumpscare in Figure 3 specifically from

the 0-5 second mark there are lower levels of heart rate variability compared to their baseline collected during the first minute in Figure 2. There is difficulty in concluding diminished levels of HRV in only anxious individuals as no non-anxious participants were included in the study. The HRV during the 5-minute meditation during the Oculus meditation session is not only constant but it has an overall smaller IBI during the whole run. Regarding the data collected via the Thermal camera and EDA, there were elevated levels of SCR and the number of sweat pores at times of stress in both figures 5 and 6 compared to the data in Figure 7. Meditation on the Oculus VR displayed the lowest numbers of active sweat pores and SCR. There was not enough evidence to decipher if Oculus meditation was better than the supported therapeutic method of 4-7-8 breathing.

As mental health becomes a more prevalent and increasingly worse matter in our society adaptations to treatment must be made to be able to provide better therapies. The use of virtual reality as a means of therapy is supported in this study and should be further researched as it may not just be limited to women on oral contraceptive birth control. In addition, virtual reality is becoming more available to the public and in the coming years could become as popular as cell phones so if research is done now to find the most effective treatment within the virtual reality universe there can be many advancements in how people with anxiety and other mental health disorders are treated. The focus of this study was on women on oral contraceptive birth control as there is a lack of information regarding certain side effects of oral contraceptive birth control including higher rates of depression, anxiety, and neurotic symptoms. The hope was to be able to provide data to support the need for proper education on what this medication can do to women's mental health and to find a new way they can help themselves with something that can be used every day and not just once a week such as seeing a therapist.

Future directions

The initial focus of this study was on women on oral contraceptive birth control and showing that anxiety is a symptom when using this type of medication. The secondary focus was to find another technique for women who suffer from anxiety symptoms that is potentially more effective and can be used more frequently. There is a new market for research in the realm of virtual reality and this experiment looks at how virtual reality produced via Oculus can create a meditation environment for those struggling with anxiety and various other mental health disorders. Recent research studies have analyzed the proper setting for virtual realities to be effective in improving mental health (14). Due to how immersive virtual reality is, researchers were able to produce realistic reactions to various stimuli allowing researchers to narrow down the proper nature and setting that is beneficial. There was a strong correlation in positive stimulation of virtual reality such as meditation settings and calm nature walks with decreased symptoms of anxiety. However, more research needs to be conducted to make these virtual reality modules more accessible and mobile to the public.

Appendix

Recruitment flyer



Research Participants Needed

Are you a woman on birth control?



If yes, would you like to participate in a research study looking at the correlation between oral contraceptive birth control and perceived anxiety?

Requirements:

- ✓ A female on oral contraceptive birth control
- ✓ Above the age of 18
- ✓ Be able to come to the University of Arizona Health Sciences campus for participation



Participant Involvement:

- ✓ A one-time visit to the lab for a maximum of 2 hours to evaluate the impact of integrative relaxation techniques on perceived anxiety
- ✓ Complete a one-time online survey and baseline State-Trait anxiety questionnaire

Interested!

Fill out our eligibility pre-survey



Contact us with questions: sweat-lab@list.arizona.edu

Qualtrics survey questions

Identifying questions:

Height?

Weight?

Gender?

Are you an enrolled student at the U of A?

If yes, are you in the state or out of state, or in-state?

If not, are you professionally employed?

Level of education:

Marital status:

Medication for anxiety/depression:

Since starting birth control:

How long have you been on birth control?

Have you noticed increased anxiety/irritability?

Have you noticed physiological changes (ie? higher BP/HR/sweat levels)?

Have you noticed any increase in the following symptoms?

-Fatigue

-Irritability

-Mood swings

-Nausea

-Headaches

-abdominal cramping

How often do you experience the above symptoms?

Have you had a recent diagnosis of anxiety or depression since starting birth control?

Have you begun using anxiety medication since starting birth control?

Daily tasks:

Throughout the day do you perform these actions?

-Cook

-Walk

-Run

-Weightlift

-Yoga

-Meditation

-Creative work (paint, draw, journal, music)

-Read

-Therapy with a certified psychologist/psychiatrist

-none of the above

Do you perform any of these above tasks as an intended way to combat symptoms of anxiety not just as part of your daily routine?

If yes, how frequently?

What time do you normally wake up?

What time do you normally go to sleep?

Do you suffer from insomnia?

If yes, do you attribute this to anxiety?

Do you take naps during the day?

Hours spent on school or professional work.

Do you feel anxious regularly?

If yes, what are some ways you cope with your anxiety?

Do you practice yoga more as a routine task? (>2 times a week, every week)

Are you a yoga instructor at an established yoga studio?

Do you perform meditation on a routine basis?

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