

Comparison of Essential Oils and Relaxing Music on Reducing Anxiety

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ABSTRACT

The purpose of this research is to identify any significant difference between two forms of alternative medicine (aromatherapy and music therapy) and the body's ability to relax unaided, in an attempt to discern if one has greater efficacy. We hypothesized that aromatherapy would be more effective than music therapy at reducing biomarker levels which correlate to anxiety. Ten students (five male and five female) from the University of Wisconsin-Madison's Physiology 435 class volunteered to take part in this study. Measurements of participants' heart rate (HR), blood pressure (BP), and respiratory rate (RR) were recorded after exercise induced anxiety. During the post-exercise relaxation period, participants were exposed to three forms of experimental stimuli in three separate trials: no stimuli (control), lavender (aromatherapy), and "Weightless" by Marconi Union (music therapy). Measurements of HR, BP, and RR were then taken again.

Statistical analysis of the experimental data compared the three trials to each other in four categories: systolic BP, diastolic BP, HR, and RR. Between each comparison no significant difference was found between any of the trials. These findings conclude that our initial hypothesis was incorrect and there is no greater efficacy between either stimuli. While many studies have found these alternative treatments to be effective in lowering anxiety, this may be due to a placebo effect or differences in methodology. In an attempt to resolve this, we suggest that future research should focus on quantifying the effect that a subject's expectations may have on their levels of relaxation, as well as altering methodology.

INTRODUCTION

In 2010 and 2011 the American Psychological Association found that 75% of Americans experienced moderate to high levels of stress (Komaroff, 2011). While the stress response can

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aid in the reaction to a threat, the effects of an elevated stress level for a prolonged amount of time can be severe. These effects can range from fatigue, lack of concentration, irritability, to much more severe effects such as increasing risk of heart attack or coronary disease (Krantz et al., 2013). As stress can be detrimental to overall health, forms of reducing stress are crucial.

Anxiety and stress are linked to multiple physiological changes, including increased heart rate (HR), blood pressure (BP), decreased extremity temperature, and quickened respiratory rate (RR) (Sharp, 1996, Giannoudis et al., 2006). Stress induces the flight-or-fight response of the sympathetic nervous system. When perceiving danger, adrenaline is released, which dilates pupils, increases RR, and increases HR in preparation to fight or flee (Lin et al., 2011).

During physical exertion, the sympathetic nervous system is responsible for preparing the body to better complete a task (Carnethon et al., 2008). In this way, physical activity can be used to represent physical or psychological stressors in an experimental setting. The parasympathetic nervous system functions to slow HR, decrease BP, and return the body to its homeostatic state (Busscher et al., 2013). At this state there is an absence of anxiety or stress, therefore the body is said to be in a relaxed state.

To treat increased levels of stress, many individuals are turning toward mind-body therapy as a form of alternative medicine. Mind-body therapy seeks to promote health by focusing on the connections of the brain, mind, body, and behavior (Wolsko et al., 2004). A 2007 study found that 4 in 10 Americans have used complementary and alternative medicine and 19.2% of the adult population, nearly 55 million people, practiced at least one form of mind-body therapy. This has created a 33.9 billion dollar industry for the practitioners and products of complementary and alternative medicine (Barnes et al., 2008). There are a variety of techniques in alternative medicine such as massage therapy, music therapy and aromatherapy. The

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increasing popularity of mind-body therapy has created a demand for research validating these forms of alternative medicine, as well as determining which therapies may be more effective than others.

One such popular form of mind-body therapy is the practice of listening to relaxing music. Music therapy has been used since 1789, and more recently has led to the creation of organizations such as the National Association for Music Therapy and the American Association for Music Therapy (American Music Therapy Association). These organizations promote modern experimentation and scientific inquiry to determine the effects of music therapy.

Recent studies in psychotherapy have shown music therapy to lower tension and anxiety when administered to individuals experiencing stress. (Jiang et al, 2013) According to the British Academy of Sound, exposure to the song “Weightless” by Marconi Union has been shown to have considerable effects on relaxation, and has lowered overall anxiety levels by as much as 65% in women who have been exposed to stressful events (The Telegraph, 2011). In addition to cognitive benefits, music has also been shown to have the potential to combat depression and enhance the immune system (Demirbatir, 2012, Kuhn, 2002). Despite the fact that new research studies and techniques have provided insight into the physiological and psychological effects of listening to music, more scientific exploration is necessary in order to fully understand music’s total cognitive effects and underlying processes.

In addition to music therapy, aromatherapy has also been shown to have effects on reducing anxiety. Aromatherapy practice began hundreds of years ago by using plants to treat disease. Aromatherapy employs the use of therapeutic essential oils, which are obtained from aromatic plants via steam distillates (Guenther, 1972). Many household essential oils have been shown to induce a change in mood. Lavender has become one of the most highly researched

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essential oils for its potential relaxative and calming effects (Warm et al., 1991). It has been used in a variety of treatments to reduce mental stress, induce sedation, improve mood, and promote relaxation (Motomura et al., 2001, Moss et al., 2003, Field et al., 2005). It also has been proven to have direct pharmacological effects through its straightforward entrance into the bloodstream through olfactory uptake (Howard et al., 2010).

It is hypothesized that aromatherapy, specifically exposure to lavender scent, will decrease anxiety more rapidly than music therapy. This hypothesis is based on the direct pharmacological properties that lavender is proven to possess, which should allow a more immediate physiological response of lowering anxiety levels. The predictions of the experiment are that there will be a significant decrease observed in these physiological biomarkers, with a p-value of less than 0.05, in subjects during lavender exposure trials in comparison with the relaxation rates of the same subjects in the music exposure trials.

METHODS

Subjects:

Ten students enrolled in Physiology 435 at the University of Wisconsin Madison volunteered to participate in the study. Five participants were male and five were female. Students with allergy induced asthma and respiratory sensitivity were not encouraged to participate.

Materials:

HR, BP, and RR were used to measure participants' anxiety. A Nonin Pulse Oximeter/Carbon Dioxide Detector (model 9843, Plymouth, MN) and a North American Wristech Blood Pressure Cuff (item model JB5538, Dana Point, CA, purchased from Amazon.com) were used to measure HR and BP respectively. A BIOPAC Respiratory Transducer (item number SS5LB,

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Goleta, CA), coupled with BIOPAC Student Lab System BSL4 Software (item number MP36/35, Goleta, CA) were used to measure RR.

Design:

The reduction of anxiety in these subjects was analyzed through a series of exposure to three different stimuli (no exposure, lavender aromatherapy, and music therapy) over the course of three trials, each spaced one week apart. During the first trial, the subjects were not exposed to any stimulus (negative control). For the second trial, the subjects were exposed to a lavender aromatherapy stimulus using Now Essential Oils 100% Pure Lavender (item model 7560, Bloomingdale, IL, purchased from Amazon.com). During the third and final trial the subjects were exposed to music therapy stimulus by listening to the song “Weightless” by Marconi Union (available on iTunes) through Bose AE2 audio headphones (item model 47684, Framingham, MA, purchased from Amazon.com).

In the experimental trials, a BIOPAC Respiratory Transducer was placed on the participant and calibrated. The strap was placed at nipple level for males and slightly above the breasts for females. The sensor was centered directly above the breastplate. The participants exercised on a stationary bicycle (Schwinn Bicycne Ergometer, Taiwan) for 90 seconds. After this time, the participant was seated. BP, HR, and RR measurements began immediately.

After measuring post exercise induced stress levels, the participants were exposed to the three forms of stimuli for two minutes. The participant was left alone in the study room during this time period. The stimulus used depended on whether the program was in its first, second, or third week. Following two minutes of stimulus exposure, the study proctors re-entered the room and took BP and HR readings using the blood pressure cuff. This measurement was recorded and RR measuring was ceased.

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During week 1, no stimulus was given, as this was the control experiment. The student was then left alone for 2 minutes to relax. During week 2, subjects were exposed to Now Essential Oils 100% Pure Lavender for 2 minutes in solitude. During week 3, subjects were exposed to auditory stimulus of the song “Weightless” by Marconi Union for 2 minutes in solitude. During each trial, the student was not told that they would be exposed to lavender (as the bag was hidden), nor that “Weightless” was deemed the “World’s most relaxing song”.

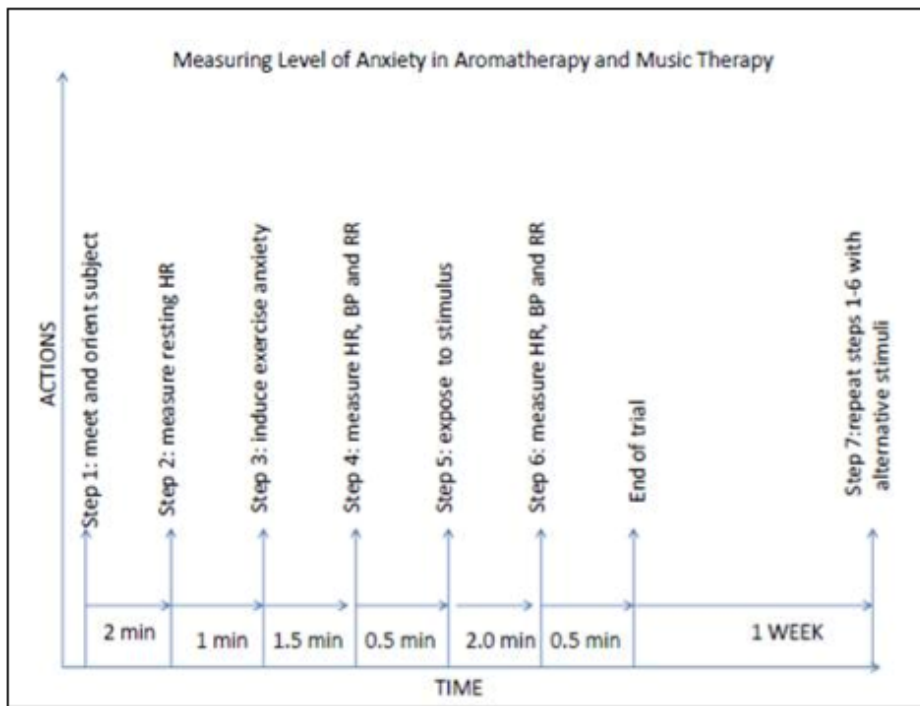


Figure 1. Flow diagram detailing the outline of the experiment.

Positive Control:

The validity of these measurements was established in preliminary trials, and will represent the experimental positive control. Five researchers participated in these trials. First the HR, RR, and BP of each researcher was taken while at rest. Following this measurement, each researcher exercised for 90 seconds on the stationary bike that was to be used during the study. After this time, measurements of HR, RR, and BP were immediately taken again. The equipment

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was accurately able to measure increases in HR, BP, and RR resulting from the exercise they had recently completed. As shown in Figure 2, panel A, systolic BP pre and post exercise shows an average percent change of $22.69\% \pm 20.98$ SD (p-value = 0.0498). As shown in Figure 2, panel B, the diastolic BP pre and post exercise resulted in an average percent change of $7.929\% \pm 17.86$ SD (p-value = 0.4419). As shown in Figure 2, panel C, the HR pre and post exercise yields an average percent change of $67.30\% \pm 15.64$ SD (p-value = 0.0082). As shown in 1, panel D, RR pre and post stimuli had an average percent change of $76.90\% \pm 31.46$ SD (p-value = 0.0154).

The percent difference in the two measurements (pre and post exercise) shows an increase in HR, Systolic BP, and RR, verifying that exercise is an effective way to mimic elevated anxiety levels. While diastolic BP was not found to be significant, other studies have found that diastolic BP does not increase with exercise. This is due to the body's natural reaction to high BP, which is to increase vessel diameter to accommodate the additional blood flow (Palatini, 1988). Therefore, diastolic BP will be used in this experiment as an additional indicator that the measurements were properly taken.

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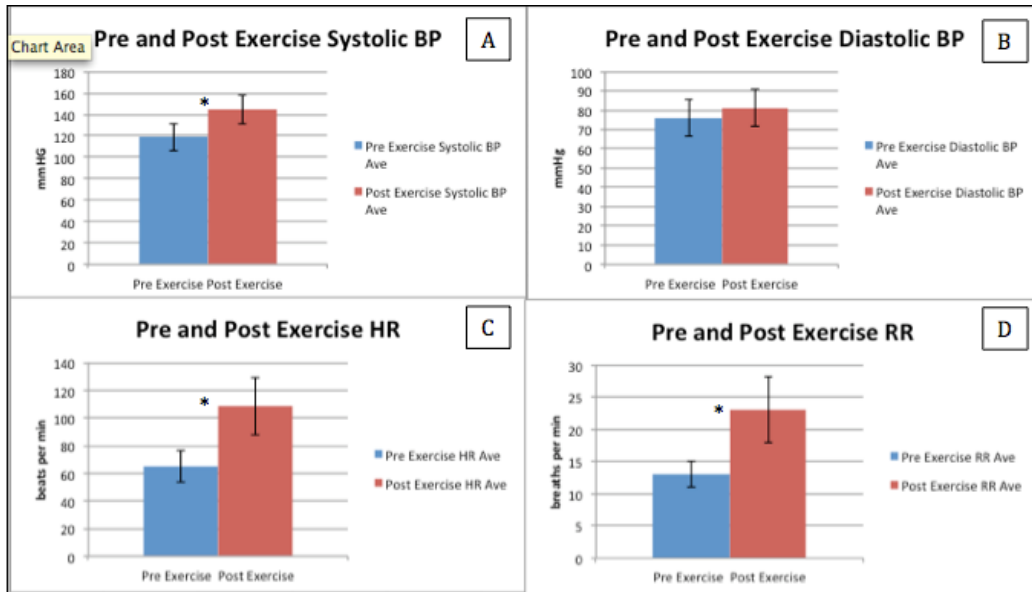


Figure 2. The positive control data showing change of four physiological markers measured (systolic BP, diastolic BP, HR, and RR) before and after a 90 sec exercise induced stress. 90 sec of exercise caused a significant increase in Systolic BP (P-value = 0.0498). 90 sec exercise caused a non-significant increase in diastolic BP (P-value = 0.4420). 90 sec Exercise caused a significant increase in HR (P-value = 0.0082). Exercise caused a significant increase in RR (P-value = .0154).

RESULTS

Data regarding the results of systolic BP measurements and exposure to the experimental stimuli yielded the following results. As shown by Figure 3, the average decrease for the systolic BP control was $-13.284\% \pm 8.664$ SD. The average decrease for lavender stimuli was $-14.33\% \pm 6.208$ SD. There was no significant decrease in the average systolic BP using lavender stimulus as compared to the control group (p-value = 0.7235 > 0.05). The average decrease in systolic BP for music stimuli was $-9.61\% \pm 9.679$ SD. This percent does not represent a significant decrease in systolic BP as compared to the control (p-value = 0.4651). Furthermore, the two stimulus' percent decrease (lavender and music) showed no significant difference (p-value 0.2365). Figure 4, panel A shows the average systolic BP after exposure to the three stimuli, from an individual who best represents the data.

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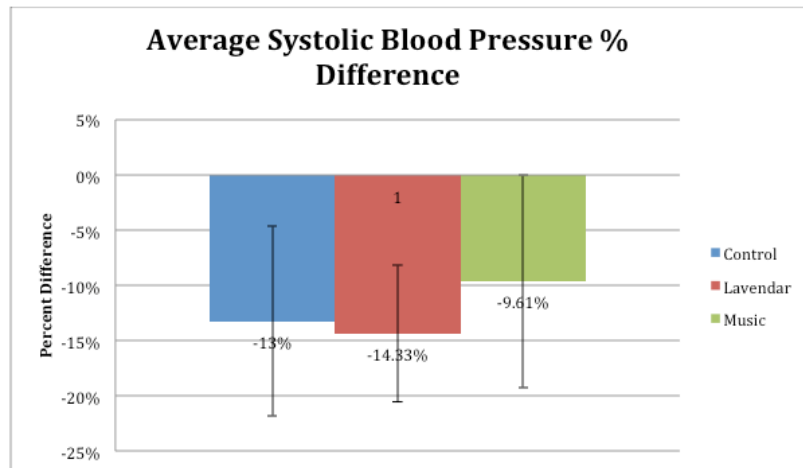


Figure 3. A representation of the average percent difference for systolic BP between pre and post stimuli for the control, lavender and music. As shown above there was no significant difference in the percent change of systolic BP between control and lavender (p-value = 0.723), control and music (p-value = 0.4651), or lavender and music (p-value = 0.236).

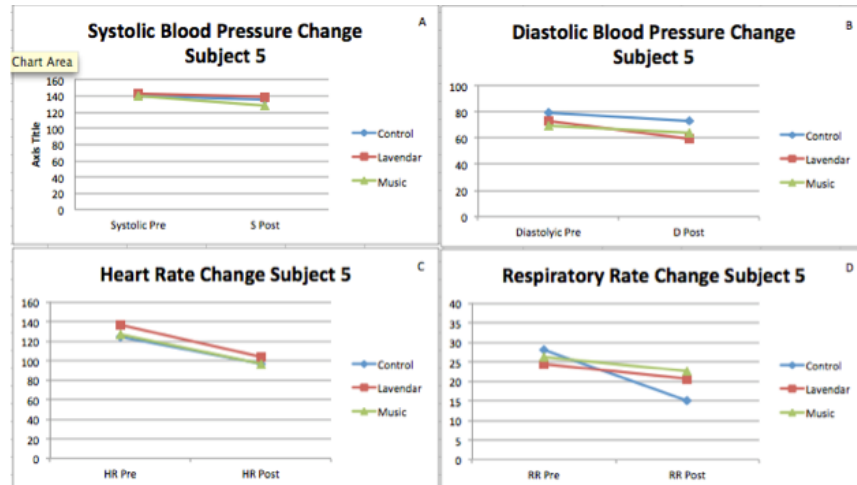


Figure 4. A representation of the raw data of four physiological biomarkers (Systolic BP, Diastolic BP, HR, RR) of an individual who has been exposed to the two stimuli (lavender and music) and best represents our data.

The average decrease in BP showed no significant results across the three stimuli. As shown by Figure 5, the average decrease for the diastolic BP was $-8.24\% \pm 12.00$ SD. The average decrease for lavender stimulus was $-12.5\% \pm 11.81$ SD. There was no significant decrease in diastolic BP after lavender stimulus as compared to the control group (p-value = 0.5160). The average decrease in diastolic BP for music was -15.59 ± 9.375 SD. This is not a significant decrease as compared to the control (p-value = 0.1854). In comparing the two stimuli (lavender and music), there is no significant difference between the average decreases of

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diastolic BP (p-value = 0.4591). Figure 4, panel B shows the change in diastolic BP after exposure to the three stimuli, from an individual who best represents the data.

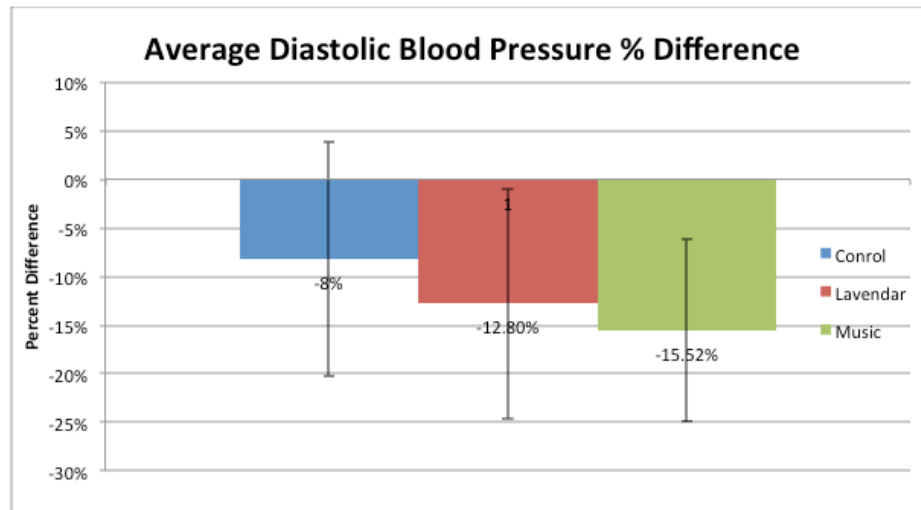


Figure 5. A representation of the average percent difference for diastolic BP between pre and post stimuli for the control, lavender and music. As shown above there was no significant difference in the percent change of diastolic BP between control and lavender (p-value = 0.5160), control and music (p-value = 0.1854), or lavender and music (p-value = 0.5491).

Figure 6 displays the average changes in HR measurements with regard to stimuli exposure. There was no significant average percent decrease in HR across the three stimuli. The average decrease in HR was $-27.56\% \pm 9.386$ SD. The average decrease for lavender stimulus was $-30.72\% \pm 7.410$ SD. There was no significant decrease in the average HR after lavender stimulus, as compared to the control group (p-value = 0.3799). The average decrease in HR after music stimuli is $-30.95\% \pm 9.199$. As compared to the control, there is not a significant difference of decreased HR after music stimuli (p-value = 0.3234). Furthermore, the two stimuli (lavender and music), when compared, show no significant difference in decrease of HR (p-value = 0.9317). Figure 4, panel C shows the change in HR after exposure to the three stimuli, from an individual who best represents the data.

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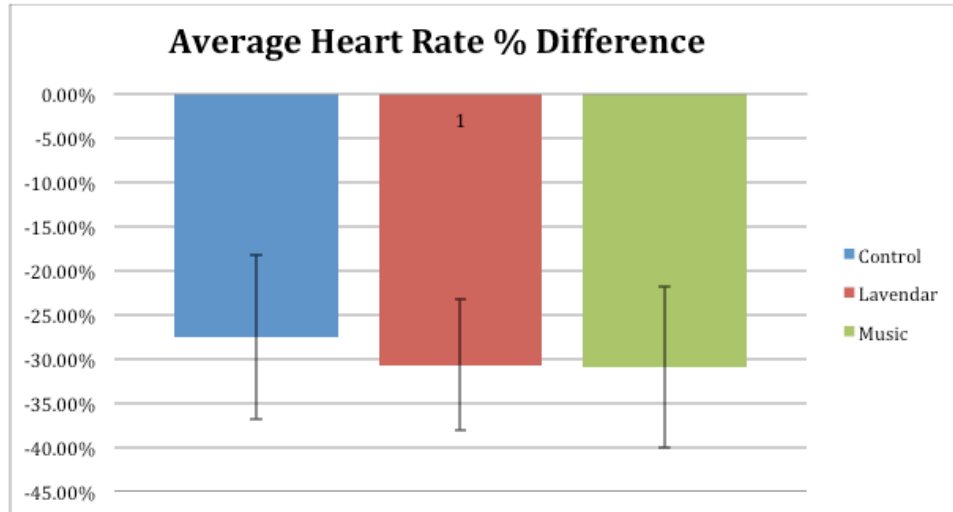


Figure 6. A representation of the average percent difference for HR between pre and post stimuli for the control, lavender and music. As shown above there was no significant difference in the percent change of HR between control and lavender (p-value = 0.3799), control and music (p-value = 0.3234), or lavender and music (p-value = 0.9317).

The RR did not cause a significant average percent decrease in subjects across the three stimuli. As shown by Figure 7, the average decrease for the RR was $-28.57\% \pm 13.52$ SD. The average decrease after lavender stimulus was $-21.33\% \pm 9.667$ SD. There was no significant difference in the average decrease of RR after lavender stimulus, as compared to the control group (p-value = 0.1280 > 0.05). The average decrease in RR after exposure to music is $-20.75\% \pm 9.721$ SD. As compared to the control, the effect of music stimuli is not significantly different (p-value = 0.1268). Furthermore, when the two stimuli (lavender and music) are compared, they are not significantly different (p-value = 0.8686). Figure 4, panel D shows the change in RR after exposure to the three stimuli, from an individual who best represents the data.

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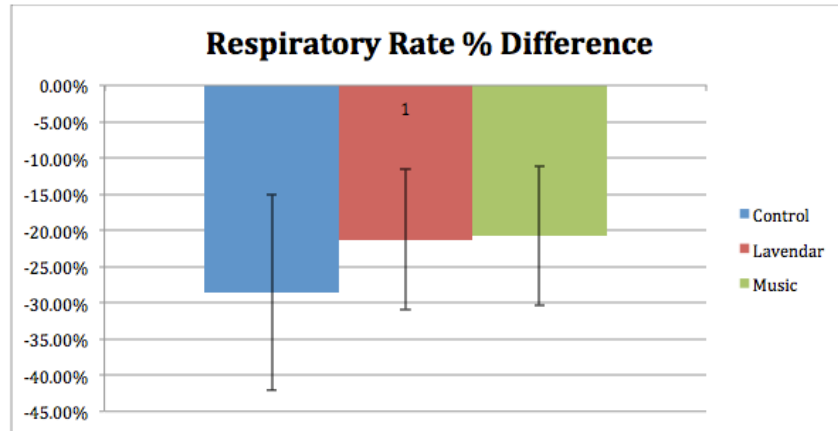


Figure 7. A representation of the average percent difference for RR between pre and post stimuli for the control, lavender and music. As shown above there was no significant difference in the percent change of RR between control and lavender (p-value = 0.1270), control and music (p-value = 0.1268), or lavender and music (p-value = 0.8686).

DISCUSSION

There was no observed significant difference in the reduction of biomarker levels after exposure to the three experimental stimuli. These reductions were not significantly different from the reductions in the control trial. In regards to a comparison between the two alternative therapies, musical and aromatic, our results indicate that there is no significant difference when compared. This data concludes that neither music therapy nor aromatherapy yields a significant decrease in reducing physiological anxiety markers. In addition, within the context of our study's design, there appears to be no additional benefit from the use of these alternative medicines.

This data does not support our initial hypothesis, that both lavender and music would cause a significant reduction in BP, HR, and RR as compared to the control. Similar to our results, several other published papers have found that music does not cause a significant reduction in anxiety. Contrary to our results, multiple studies found lavender to be effective in the reduction of anxiety. However, discrepancy in methodology between studies caused mixed results in the effectiveness of alternative therapies.

Lori A. Russell found that exposing university students with high anxiety to music therapy interventions had a limited effect on their levels of anxiety (Russell, 1992). Russell's experiment was comprised of a population possessing similar demographics to our study, and is a strong comparison to our findings. Although exposure to music has commonly been seen to increase mood levels, it has only been correlated to small reductions in RR levels and other vital sign parameters (Eliakim et al., 2013, Ratcliff et al., 2014, Evans, 2002). Mood levels associated with music are often strictly dependent on the subjects' personal music preferences (Barnason et al., 1995, Ratcliff et al., 2014). In our experiment the subjects did not choose the song that they were listening to, and if "Weightless" by Marconi Union was not to their personal preference, it may have had an impact on their mood, and consequently affected measurements of their physiological biomarkers.

In previous research yielding significant results, the stimuli was delivered to a larger pool of individuals (Howard et al., 2010, Wiebe, 2000). The small participant pool of our study may have caused the insignificant decrease in BP, HR and RR, as compared to our control. In addition, previous studies that found efficacy in these alternative medicines administered stimuli for longer periods of time (Howard et al., 2010, Wiebe, 2000, Barnason et al., 1995, Eliakim et al., 2013). Limited exposure time could be another factor as to why the insignificant difference in subjects' physiological variables was found within our study.

Throughout aromatherapy research, changes in methodology have caused varying results among studies. Administration of the treatment has not been standardized throughout experiments, which does not allow for a comprehensive assessment of its effectiveness (Evans, 2002). The environment in which the subjects received the treatment differed throughout studies that yielded a positive correlation. Such as, in some studies subjects were in cubicles during

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treatment administration, while other in other studies subjects were left in solitude in a soundproof room (Moss et al., 2003, Motomura et al., 2001). Our experiment was isolated, but the room was not soundproof and the individuals were not left in solitude for an extended period of time. This difference in methodology could have potentially caused a discrepancy in our results, as compared to other studies. Likewise, the administration of the stimuli in our experiment was difficult to control and may have affected our results. In studies in which aromatherapy caused a significant difference in relaxation, diffusers or oxygen masks were used, providing a more controlled exposure (Moss et al., 2002, Warm et al., 1990).

It is important to consider potential limitations and unforeseen complications in our study. Using a single-subject design created considerable time constraints for data measurement and limited the size of our testable subject pool, decreasing the statistical power. Having the time to measure an increased number of test subjects could have altered the results. Another confounding factor regarding the consistency of our data collection was the physical fitness variability between individuals. 90 seconds of exercise did not sufficiently increase physiological biomarkers of anxiety of some participants to create a significant difference between their relaxed and excited state. In a study that showed aromatherapy had a significant relaxing effect, different stimuli were given to represent different forms of physiological stress, such as exercise or fright. Using a stressor other than exercise could yield a more unified result, such as a mental arithmetic task (Motomura et al., 2001, Jiang, 2013).

Although the initial focus of the experiment was to analyze the difference in effectiveness in decreasing anxiety in aromatherapy and music, our data suggests that these alternative medicines have no benefit in reducing anxiety. While there are many examples of the beneficial effects of these alternative treatments, other research has proposed that this may be due to a

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placebo effect and not due to a direct physiological effect (Howard et al., 2010, Wiebe, 2000).

The addition of a psychological test such as Spielberger's state-trait anxiety inventory (STAI), which is comprised of 40 questions ranking how a person feels and why they feel so, has been included in many published articles, and may add additional validity to the question of whether stimuli have a direct psychological effect (Spielberger et al., 1970, Barnason et al., 1995). This explanation suggests that future research should focus on quantifying the degree to which the placebo effect may impact an individual's response to reducing anxiety both physiologically and psychologically.

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