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EEG Analysis: The Effects of Music on Relaxation

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ABSTRACT

In today's society many people are looking for something to help them relax. There are different drugs, religious practices, exercises, types of music, etc. constantly being used. This study compared the effects of three music conditions, (no music, classical, and hard rock) on the relaxation of 14 college students. To measure relaxation EEGs were recorded and then analyzed using a Friedman test. The expected results were that the alpha waves would increase while the beta decreased. After analysis, no statistically significant difference in the brain wave measurements of the three different variables could be determined. For future research an increased sample size might detect a statistically significant difference.

Keywords: *Music, relaxation, EEG, Classical, Hard Rock*

INTRODUCTION

There are many techniques people use to help them relax; music, meditation, yoga, prayer, imagery, breathing exercises, muscle relaxation, medication, etc. Various studies have been done to try to find methods to help people relax without medication. Many studies try to analyze the techniques' effects on sleep efficiency or quality. It is difficult to measure the effectiveness of these techniques because the objective measurements of the quality of sleep and the subjective answers do not always show a correlation (Ziv etal, 2008). Knowing the most effective relaxation techniques can be useful for treating problems like insomnia, stress, hypertension, anxiety, depression, for helping people with chronic pain, improving the immune system response, controlling emotions, and all-around bettering people's quality of life.

A study done to compare the effect of music on relaxation vs. progressive muscle relaxation used an ActiGraph to objectively measure sleep and wake cycles by sampling wrist movements. For a subjective measurement a mini sleep questionnaire was used (Ziv etal, 2008). Another study that compared the effect of a relaxing classical music tape vs. audiobook on sleep in students used three different subjective questionnaires, the PSQI (Pittsburg Sleep Quality Index) to rate sleep, the BDI (Beck Depression Inventory) to measure mood and depression, and the ESS (Epworth Sleepiness Scale) for depression and daytime sleepiness (Harmat etal, 2008). Another study only looked at the effects of a musical tape vs. no music in older adults also using the PSQI as well as testing the heart rate and respiratory rate before and after listening to the tape for the first time to determine if it decreased the subjects autonomic reflexes. This study also allowed the subject to choose from different musical selections with the same tempo range of 60-80 beats/min. The subjects were given time to become accustomed to the music and practice relaxing to it before evaluating its effectiveness (Hui-Ling, 2005). Three other studies looked at the effectiveness of different types of music to reduce stress (Burns etal, 2008; Iwanaga, and Moroki, 1999; Labbé etal, 2007). Burns etal (2008) noted the surprisingly small amount of studies done on the effects of different kinds of music on stress, finding only one which was Iwanaga, and Moroki (1999). Iwanaga, and Moroki's (1999) paper noted the inconclusiveness of several studies, attributing it to a lack of controlled musical stimuli. All three studies subjects were undergrad college students around the age of the subjects to be worked with in this study. Another study looked at compared the changes in theta and alpha brain waves in subjects listening to a relaxation tape with body scan, breathing, and mental focusing techniques vs. listening to a tape of classical or new age music, using a spectral analysis of an EEG with 14 different electrode sites on the scalp. These subjects were given 6 weeks to practice relaxing with the tape every day and then they tested its effectiveness at the end of that time period (Jacobs and Friedman, 2004). The EEG records the small electrical signals that are continuously sent out by the brain. It then separates them into the four different frequency patterns: Alpha, Beta, Theta, and Delta. Through research scientists have been trying to figure out which brain wave is dominant during which brain state.

For this study we will compare the effect of Bach, for slow tempo softer music, 3 Doors Down for up tempo harder beat music, and silence on relaxation in 14 subjects, six female and eight male. A EEG recording will be used for an objective measurement of relaxation. For this research, Electroencephalography techniques very similar to those used in Jacobs and Friedman's (2004) research will be used. For a subjective response of relaxation a method more like that of Burns etal (1999); Iwanaga, and Moroki (1999); and Labbé's

etal (2007) research experiments will be used. The effectiveness of using the EEG will be determined by combining some of the techniques to minimize the variation in the control variables that could affect the data between each EEG recording session, from the various studies discussed. The EEG was used as the objective measurement of relaxation. The alpha wave measurements should show a significant increase when relaxed while the beta waves should show a significant decrease.

MATERIALS AND METHODS

Fourteen participants volunteered to be part of the study, six female and 8 male with an age range of 18-22. Each participant claimed to not have any disorder or be on any medication that to their knowledge would affect their ability to relax positively or negatively. Each participant also agreed to avoid the intake of caffeine for at least six hours and nicotine for two hours prior to each test run because they would affect the subjects' ability to relax (Jacobs and Friedman, 2004).

Over the course of three weeks each subject was asked to come in for approximately a half hour to go through the process of recording their EEG once a week. The time and day each subject came in the same as possible each week was kept the same as possible so that their level of activity and sleep would be less varied. However due to subjects forgetting to avoid caffeine or because of scheduling conflicts there were a few participants whose times and days were different on one of the weeks. Before each session the subject was asked if they had avoided caffeine for at least six hours and nicotine for at least two hours prior to each session. (Jacobs and Friedman, 2004).

The iWorx program, and the AAMI cable with five electrode leads were used to record the EEGs of the participants while relaxing for 20 minutes without music, to tracks 1,3,5,7, and 12 from the London Philharmonic's Timeless Classics CD of selections of Bach's music, or to tracks 1, 2, 3,7,10, and 11 from the music group 3 Doors Down's self-titled album. The same setup as in the Human Physiology EEG Experiment HP-1 (iWorx) was used, shown in figure 1. A procedure similar to that of exercise five was used for the baseline recording. To help insure the connection of the electrodes is maintained a headband was wrapped around them.

The subject was then asked to lay down keeping their eyes open and moving as little as possible, while I recorded a baseline for five minutes. During the baseline they were asked to blink three different times approx. 30 seconds apart, and rotate their head from side to side approx. 45 seconds apart. After the first baseline each subject was asked how often they listened to classical, country, pop, hard rock/heavy metal, rap, or latin music, either daily,

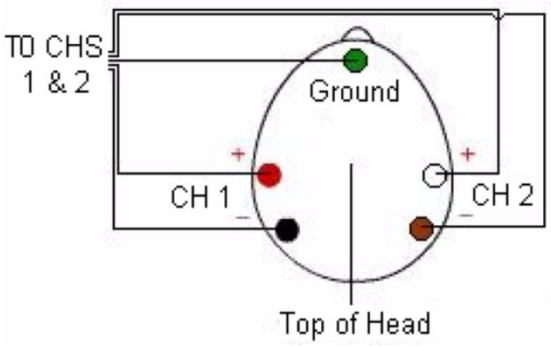

Figure 1 Diagram of the placement of the electrodes. (iWorx)

weekly, monthly, yearly, or never. After every baseline they were asked to rate their level of relaxation from 1 to 10; 1 not relaxed and 10 very relaxed, which is the reverse of the scale Burns used (1999). Then the subject was instructed to lay quietly and relax as best as possible while their EEG was recorded for 20 minutes with either no music, Bach, or 3 Doors Down depending on the group they were in, and informed that it was okay if they fell asleep. After the 20 minutes were up the subject was asked how relaxed they thought they were on the same scale of one to ten. The next week the procedure was repeated under different music conditions, except they were not asked how often they listened to the different types of music. The third week the procedure was once again repeated under the condition that the participant had not yet been subjected to. Ten second sections as free from artifacts as possible in the 1st 5th, 10th, 15th, and 20th minutes of each recording were used to calculate the means of the left and right alpha and beta brain wave frequencies, and the difference between the max and min for the left and right alpha and beta brain wave amplitudes as well as for the left and right EEG. Then the difference between the 1st and the 5th, the 1st and the 10th, the 1st and the 15th, and the 1st and the 20th was determined. Only the difference between the 10th and 1st minute was used because some subjects were observed falling asleep around the 11th minute of recording.

A Shapiro-Wilk test was run to determine if the data met the assumption of normality to run a parametric ANOVA. The distribution was not normal so the non-parametric Friedman test was used to analyze the data.

RESULTS

Due to one subject's inability to lay still during the recording, and bad electrode connections with three other subjects, their data was unusable so only 10 subjects data points were analyzed.

The normality assumption was not met, therefore a

Table 1 EEG measurements under different musical conditions. Did not differ significantly P>.005. Values are means (SD).

	Music Condition		
EEG measurement	No Music	Bach	3 Doors Down
Left	-19.383 (27.589)	-8.0322 (57.006)	-21.6336 (18.445)
Right	-11.1482 (29.442)	-17.966 (19.843)	-22.2814 (39.483)
Left Alpha Amp	-11.8619 (25.700)	-17.113 (1.919)	-2.0896 (1.419)
Left Alpha Freq	-9.3974 (18.154)	-1.9985 (14.068)	-0.6671 (17.025)
Left Beta Amp	-4.3674 (6.918)	-7.7023 (12.183)	-3.1905 (5.733)
Left Beta Freq	-0.1944 (3.227)	0.1272 (3.779)	1.2726 (3.645)
Right Alpha Amp	-8.6685 (14.865)	-11.7877 (9.758)	-7.5449 (18.829)
Right Alpha Freq	-0.5101 (2.544)	-1.6593 (1.980)	-1.3752 (2.375)
Right Beta Amp	-3.3102 (5.691)	-6.1499 (6.022)	-5.0007 (7.273)
Right Beta Freq	-1.6882 (5.293)	-1.5984 (6.117)	2.8007 (4.866)

Friedman test was conducted on the difference between the 10th and the 1st minute for each EEG measurement. The necessary p-value of .005 wasn't met by any of the EEG measurement, as shown in Table 2, therefore there is not a statistically significant difference between the EEG measurements for the different music conditions.

Table 2 Friedman test P-values for the EEG measurements. Did not differ significantly P>.005

	p-value
Left	0.273
Right	0.741
Left Alpha Amp	0.067
Left Alpha Freq	0.202
Left Beta Amp	0.67
Left Beta Freq	0.741
Right Alpha Amp	0.497
Right Alpha Freq	0.202
Right Beta Amp	0.497
Right Beta Freq	0.045

DISCUSSION

These results show that there is not a statistically significant difference between the EEG measurements of the different music conditions. Therefore the null hypothesis that the music condition doesn't affect the EEG recording must be accepted. The small sample size may have made a statistical difference difficult to find. Another potential reason for there not being a statistical difference could be human in the experiment. The lack of finding a statistical difference may also suggest either that the EEG is not a good instrument for measuring relaxation while listening to music or that this generation is relaxed by different types of music from previously researched generations.

The results of this study may have been affected by several factors, such as if the placement of the electrodes was not completely consistent, or the connection being interfered by hair or not sticking to the scalp. The study also relied on the integrity of the subjects to avoid caffeine and tobacco for the set time period prior to each test. If by accident or on purpose they had either of these and failed to tell me it could have affected the results. The results may also have been affected by the difference between each song used during a test. Another potential factor that may have affected the results would be in the analysis; whether or not the selected sections of data were completely free of artifacts,

In future to help control these factors the experimenter should have a larger sample size, practice and/or training in attaching electrodes and analyzing the EEG output. Another method that might help make the reading more accurate would be to select subjects that were previously confirmed to be able to lie still for 20 minutes at a time as well as being willing to have the location of the electrode placement marked, so that it is the same for each test. Selecting one song for each category of music that would be tested might help decrease variation as well. Also to help decrease variation, it might help if the music preference of all the subjects was similar. Another idea for future research would be to expand the categories of different types of music and a larger group of test subjects.

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