
LUND
UNIVERSITY

DEPARTMENT OF PSYCHOLOGY

# The Beneficial Effects of Relaxation Techniques on Stress, Memory and Attention

Master Thesis Spring 2014

*By Kanellakou Christina*

*Supervisor(s): Kai Österberg*

Lund University

Abstract

High levels of stress have been documented to impact memory and attention. On the other hand according to previous literature low levels of stress can be helpful in preparing individuals physically and mentally to become active. Relaxation techniques have been proved to reduce stress successfully but there is debate regarding if they have the same positive effects on cognitive performance as well. In the present study we tried to investigate the effects of Kaspereen's relaxation technique combined with "sedative" (soft- tempo) music on the levels of stress scores and cognitive performance scores among students. Therefore, 40 females students from different universities in Sweden, were recruited for this experiment, to examine if Kaspereen's relaxation technique can be beneficial not only for stress but for memory and attention as well. Our findings on stress and memory, demonstrate support for our hypotheses. Memory scores of the experimental group, increased from pre- measurements to post-measurements while stress was reduced. Concerning attention we didn't have adequate evidence to support our hypothesis.

*Keywords:* Stress reduction, Cognition, Cognitive Performance.

Cognitive health can be defined as the maintenance of cognitive abilities that enable social connectedness, foster a sense of purpose, promote independent living, allow recovery from illness or injury and promote effective coping with functional deficits (Findlow, Price, Hochhalter, Laditka & James, 2010).

Stress on the other hand, is a condition under which our physiology exhibits a deviation from it's baseline measures, therefore our body's well-being suffers as well as our performance on a variety of tasks. The physiological responses that accompany such variations in baseline measures include bodily changes like increased muscle tension and heart rate, less saliva in the mouth, increased perspiration, changes in respiratory rate among others, but also changes on brain waves.

McEwen and Sapolsky (1995, p. 205) note that cognition is also affected with "stress acting via catecholamines and glucocorticoids, with the former acting more rapidly than the latter". Evidence attributes some of the effects to reversible changes of neurons within the hippocampus with regards to their morphology. Stress, when present for brief periods of time, can enhance memory formation, while longer lasting or more severe stressors have deleterious effects on a broad range of cognitive tasks. During prolonged periods of exposure to stress the hippocampus suffers from a loss of neurons. It is suggested that the changes that take effect in the hippocampus are related to glucocorticoid- induced cognitive impairments that involve declarative memory. Human learning and memory are inhibited by high levels of glucocorticoids. Catecholamine effects on emotionally laden memory induced by stress, are connected with structures such as the amygdala. Encoding and storing is influenced by emotional stress where peripheral details are not processed as fully as central ones. Moreover, intensively stressful events are encoded differently than non-stressful events (McEwen & Sapolsky, 1995).

**Stress and cognitive function**

Although the focus of most of the studies concerning the effects of stress on memory has been limited to the effects of stress on declarative memory, a study from Guenzel and collaborators, proved that the effects induced by stress on memory do not only concern

declarative memory but also other memory retrieval processes such as Stimuli- Response Memory Retrieval (Guenzel, Wolf & Schwabe, 2013).

Moreover the results of a study examining the effects of cortisol (hormone that is released as a response to stress) on students cognition while being in examination stress, indicated that although there was an enhancement of short memory, there was an impairment in attention instead. These results made researchers hypothesize that the corticosteroids effects on cognitive function are "selective" (Vedhara, Hyde, Gilchrist, Tytherleigh & Plummer, 2000) but actually this might be explained by individual differences in cortisol reactivity (Buchanan, Tranel & Adolphs, 2006) or be due to other psychological determinants (Lupien, Maheu, Tu, Fiocco & Schramek, 2007). Buchanan and his collaborators separated their sample in cortisol responders and non- responders and observed that there were not only significant differences between the memory scores of cortisol responders and non- responders but also between the cortisol responders and the control group which led them to the conclusion that cortisol reactivity is mainly responsible for at least some of the cognitive impairments induced by stress on individual's cognition (Buchanan et al., 2006).

A study from Bohnen and colleagues was another indicator that the individual's exhibition of high cortisol levels was related with impairments on divided attention when measured in relation to the control group of the experiment. Nevertheless memory didn't seem to be affected at all from the same factor (Bohnen, Houx, Nicolson & Jolles, 1990).

One more researcher that tried to examine the effects of cortisol in cognitive function and more specifically on memory was Kirschbaum, who finally after several measurements, ended up to the conclusion that cortisol levels induced from stress have a negative effect on individuals memory since the results of his study clearly demonstrated that there was a significant negative relationship between the two variables. When further on he tried to examine the effects of cortisol on memory without being induced by stress, he realized again that high cortisol levels were responsible for poor declarative memory and spatial thinking performance (Kirschbaum, Wolf, May, Wippich, & Hellhammer, 1996).

Moreover a study conducted from McEwen and his colleagues examining which are the effects of psychosocial stress on attentional control and prefrontal processing, revealed that there were some significant impairments on participant's attentional control, while their functional connectivity was disturbed and that these changes were reversible after stress was reduced for a month (Liston, McEwen & Casey, 2008).

**Relaxation in relation to stress and cognitive performance**

In 1974, we had the first description of what was defined as the "relaxation response" by Dr. Herbert Benson (1968; as cited in Galvin, Benson, Deckro, Fricchione & Dusek, 2006). The characteristics of this response were decreased arousal coupled with diminished heart rate, respiratory rate and blood pressure in combination with a state of "well- being" that probably resist to the physiological responses of stress like Cannon's (1929) "flight or fight" response (as cited in Galvin et al., 2006).

Since then many techniques such as meditation, breathing exercises, muscle relaxation, yoga, music relaxation and others have been used as interventions and have been proved not only to reduce stress (Kaspereen, 2012; Dendato & Diener, 1986) but also to improve aspects of cognitive performance such as attention and working memory (Lindsay & Morrison, 1996). Lindsay and Morrison, during their survey about individuals with moderate Intellectual disabilities, noticed that Behavioral Relaxation Therapy (BRT) worked beneficially for participants through time, increasing their short memory performance and decreasing perceived stress (self assessed anxiety) compared to the control group that didn't share the same results. However there was no indication of BRT increasing the participant's long- term memory as well. Furthermore considering the study of Jennifer A. Galvin, (2006), the results showed that the facilitation of a 5 week relaxation- response training program helped participants to improve their reaction time on an attention psychomotor task, as their stress levels were also reduced (Galvin et al., 2006). In 2012, Kaspereen tried also among others to prove that relaxation techniques can equally heal stress, supporting that " Relaxation Technique takes into consideration the relationship between thoughts, feelings, and physiological responses as and is a technique for teaching people to reduce strain without using external aids, such as medication" (as cited in Kaspereen, 2012, p. 239). The relaxation technique that she used in her study is

referred to as “tertiary prevention” and in combination with “primary” and “secondary prevention”, it can be really important in helping eliminating stress (Quick, 1997). The results again showed that overall stress and perceived work stress, were successfully decreased (Kaspereen, 2012).

“Meditation is defined as the practice of uncritically attempting to focus our attention on one thing at a time” (Davis, Eshelman & McKay, 2013, p. 35). Meditation appears to be as successful as any other relaxation technique but, although widely known almost to everybody, still is a new comer in the scientific field. Therefore not so much literature exist describing experiments using meditation as a relaxation technique. However a medical study that examined the possible effects of meditation (as relaxation technique) on the cognitive changes that occur while being stressed, noted that when participants were meditating before the stressor, the negative effects of stress were reduced and while memory was significantly increased, cortisol levels were decreased. So even if the negative effects of stress were diminished the positive ones (improved memory scores) were still there (Mohan, Sharma & Bijlani, 2011).

Another form of meditation practice used from Chinese researchers was the Integrative body- mind training (IBMT) or otherwise the one known as Integrative Meditation (Tang et al., 2007). This method that comprises numerous body- mind techniques (e.g. mindfulness training in combination with music, breath adjustment, mental imagery, body relaxation) first appeared in 1990, but Chinese researchers started to study its effects in 1995. When used in a study as a relaxation technique in order for researchers to measure it’s effects on stress, attention and self-regulation, the results showed that the participants that had been assigned to five days meditation before the attention test, performed higher and were able to regulate their stress easier than the ones within the control group (Tang et al., 2007).

**The effects of music on stress and cognitive performance**

In general, music has been categorized, according to specific stimulatory and sedative properties, into two main types. The first is the stimulative category of music, which mainly includes fast tempos, loud volume and rhythmic patterns while the second is the sedative category, which mainly includes slow tempos, soft volume and a little bit of rhythmic motion.

Sedative music has been suggested to be more helpful in reducing anxiety levels than the stimulative one, as long as participant's music preference is not involved (Jiang, Zhou, Rickson & Jiang, 2013).

Furthermore, numerous studies have shown that when relaxation techniques are combined with the appropriate type of music, they become more effective in reducing stress and also in some cases in increasing the individual's cognitive functioning (Kaspereen, 2012; Roden, Grube, Bongard & Kreutz, 2014).

Additionally another study examining how music affects an individual's stress response showed that although participant's cortisol levels were lower in a water sound condition compared to relaxation music condition or to the control one, still the group assigned to the relaxation music condition exhibited faster recovery from the stressor in contrast to the control group. Despite that these findings do not support that music can help in reducing stress they still demonstrate music's beneficial capabilities in recovering from the stressor's induced effects (Thoma et al., 2013).

Moreover, in 2007 another study while trying to test the possible effectiveness of different types of music on stress, the researchers separated their sample in two groups. Half of the participants would listen to classical or relaxing music of their preference and the other half would hear metal music or would stay in silence. The findings of this study revealed as expected that both stress levels and feelings of negativity of the first group were significantly decreased while relaxation feelings were increased in comparison to the heavy metal or silence group (Labbe, Schmidt, Babin & Pharr, 2007).

In the present study we tried to test and measure the effects of Kaspereen's relaxation technique combined with "sedative" music on stress levels and cognitive performance scores among students. Moreover we hypothesize that the relaxation technique of our preference in combination to relaxation music would reduce stress and through stress reduction would also increase working memory and attention. Moreover its worth to be mentioned that the experimenter chose this technique because it includes both breathing relaxation and imagery and

actually it's a kind of meditation- relaxation exercise that has been rarely used in the past. The difference from Kaspereen's technique is that the voice guiding the participants through relaxation and the music were both pre- recorded in an attempt to standardize the conditions as much as possible.

Driven from the background above this research will examine the following hypotheses:

*Hypothesis 1: Relaxation technique can reduce stress.*

*Hypothesis 2: Relaxation techniques through reduction of stress will increase memory.*

*Hypothesis 3: Relaxation techniques through reduction of stress will increase attention.*

## Methods

### Design

The study comprised measurements of cognitive performance and self-ratings of stress before and after relaxation training was given. A control group was examined with the identical procedure, but given no relaxation training.

The design of the study was set up as a two by two mixed models experimental design with three distinct dependent variables. More specifically, it consists of two independent variables, Time and Group, with two levels each; Time (Pre vs. Post) and Group (Experimental vs. Control). Moreover, the three dependent variables are Reported Stress levels, Working Memory scores and Sustained and Selective Attention. The study was anonymous and in order for participants to feel more comfortable, the experimenter used numbers as ID codes instead of names.

### Participants

Forty Bachelor and Master international students (n=40) from different universities in Sweden, were recruited through convenience sampling and randomly assigned to two different groups (control- experimental), by using a coin-toss selection method. All participants were female English speakers from 20 to 30 years old who had been informed that their participation in the study was completely voluntary and that they were allowed to leave any time they wanted

as agreed upon by giving a written consent with their signature before the experiment. Moreover the participants were informed about the experiment through web announcements and were able to book their appointment any time they wished as long as it was within the experiment's given time frame.

**Materials**

The test used to measure levels of stress was the Stress- Energy Inventory (Kjellberg & Wadman, 2002). Stress- Energy Inventory is a self-report checklist that asks the participants how much they experience each given adjective, within a specific moment, and measures feelings of arousal in two distinct traits, stress and energy, through the use of twelve items (adjectives). The stress dimension includes both adjectives that describe negatively valued high-stress states such as stressed, pressured and tense but also adjectives that describe positively valued low-stress states such as relaxed, calm and rested. The energy dimension on the other hand consists of adjectives that refer to positively valued high-energy states such as energetic, focused and active and also other that describe negatively valued low-energy states such as passive, inefficient and dull. It's worth specifying that the energy scale, was not used at all for this study. Furthermore, subject's responses are measured through the use of a 0-5 likert type scale (ranging from not at all to very much), where the participant has to rate his/her own feelings in a specific moment towards the given adjectives. The manual indicates three items for stress and three items for energy as reverse score items (1, 4, 7, 8, 11 and 12). For this experiment the summative score, ranging from 0 to 30, of each participant's responses on the stress items was used to quantify self-reported stress levels.

The Digit Span WMS-III by Wechsler (1997) was also used in order to measure participant's memory scores. It consists of eight patterns of series of numbers which range from two to nine (2- 9), that participants have to recall after hearing them once in the correct order (forwards) and seven pairs of series of numbers which span from two to eight (2-8), that need to be recalled in a reversed order (backwards). In this study, the answers were verbally provided by the participants and recorded by the experimenter. As long as participants' responses were correct, new series of the numbers with increasing length were read to them. When participants

would fail to respond correctly on a consecutive pair of series of numbers, the experimenter would terminate the first part of the test and move to the second part. After failing again to respond correctly on a consecutive pair of series of numbers, the test was terminated. Finally, all scores are added on each section in order to come up with a total score that will represent the participant's memory performance with higher scores indicating greater memory performance.

The Integrated Visual and Auditory Continuous Performance Test (IVA+ plus) is a combination of auditory and visual continuous computerize performance test, which measures among others an individual's sustained and selective attention (Sandford & Turner, 2004; Sandford & Turner, 2005). The task lasts approximately fifteen minutes as the individual sits in front of a computer screen while wearing headphones where the numbers 1 and 2 are continuously displayed in different time intervals either visually or auditorily. The task demands from the participant to click the mouse every time she/ he sees or hears the number one ignoring number two completely. During some parts of the test number 1 appears more often than number 2 and during some other segments 1 appears rarely, increasing this way the possibilities for errors. From the IVA+ Plus, for this experiment, we only utilized the full-scale attention quotient, which is presented as a numeric quotient score with a mean of 100 and a standard deviation of 15.

**Relaxation technique**

Two materials comprised the relaxation intervention used on the experiment. The first was a soundtrack of sedative music. The soundtrack was comprised of soft- tempo music combined with different sounds of nature (e.g., water sounds, birds voices). The second was a text from Kaspereen (2012) providing directions for a relaxation technique. Furthermore, the text was pre- recorded by a female assistant to maintain standardization. Finally, it was combined with the music track in order for the participants to be able to listen to it as a whole during the sessions with the use of laboratory headphones. For the control group a common magazine was used as an alternative task to the intervention.

**Procedure**

As the participant entered the room the first task was to read the informed consent and if agree sign it. Then the participants were instructed to sit wherever they were feeling most comfortable so the experimental procedure could start. Participants were then asked to fill up the Stress and Energy Inventory checklist with adjectives describing their mood in that specific moment. Moreover, the digit- span memory test followed starting with the correct order (forwards) recall condition and then moving to the reversed (backwards) recall condition (Kjellberg & Wadman, 2002; Wechsler, 1997).

For their third task, the participants were asked to sit comfortably on an indicated chair, focus on a computer screen and be ready to respond according to the instructions, by clicking the mouse. The IVA+ Plus would start with a practice trial in order for the participants to warm up and familiarize with the process and for the experimenter to make sure that they had understood the procedure. In rare cases that the participant was failing to respond three times during the practice trial, the experimenter had to interrupt the test for a minute and ask the participants to tell him what they think have been asked to do. If the participant's response to this question was correct then the test was moving on to the normal trial. If not the experimenter had to repeat the instructions (Sandford & Turner, 2004; Sandford & Turner, 2005).

The next task followed after the tests, was the relaxation intervention for the experimental group and the neutral task for the control group. During the relaxation intervention the participants were instructed again to sit comfortable in a couch and try to relax while listening to the combination of the "sedative" music and the intervention's text for approximately ten minutes. They were also instructed to follow the given instructions from the intervention as much as they could. For the control group the analogous neutral task was for participants to sit comfortable in their seat and for approximately ten minutes to flip through a fashion magazine. After the intervention or neutral task was completed, the participants would again go through the same series of tests as before, namely SEI, Digit-Span WMS-III and IVA+ Plus. You can refer to Figure 1 for the sequencing of the experimental procedures within this research. Finally, after the completion of the second measurements, each participant was individually debriefed and thanked by the experimenter.

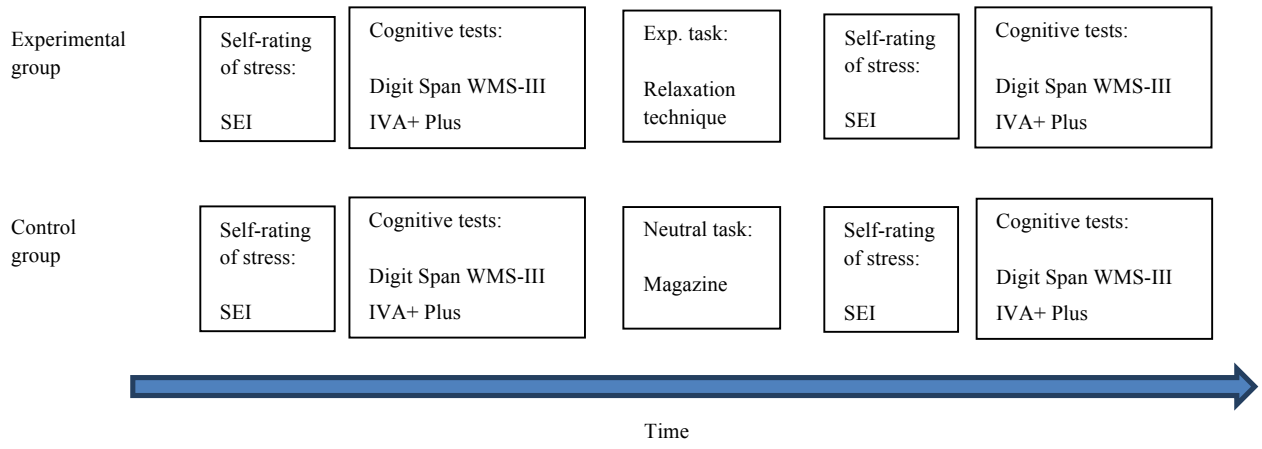


*Figure 1*. Flowchart of the main experimental procedures through time for each group level.

## Results

All statistical tests throughout the analysis were two-tailed and used a critical alpha value (α) of .05.

### Statistical Analyses

Stress

To test the first hypothesis, a 2x2 mixed-groups factorial analysis of variance was performed to examine the effects of relaxation intervention on stress scores (see Figure 2). We observed a decrease in the experimental group's stress scores from the pre-test (M = 12.7, SD = 7.43) to the post-test (M = 6.3, SD = 3.4) and a smaller decrease for the control group's stress scores from the pre-test (M = 12.7, SD = 7.69) to the post-test (M = 10.4, SD = 5.99). There was a statistically significant main effect for time, $F(1,38) = 18.03$, $p < .05$. On the other hand, there was no main effect of group exhibited with $F(1,38) = 1.41$, $p = .243$. Moreover, the results approximated a statistically significant interaction between group and time, $F(1,38) = 4.01$, $p = .053$.

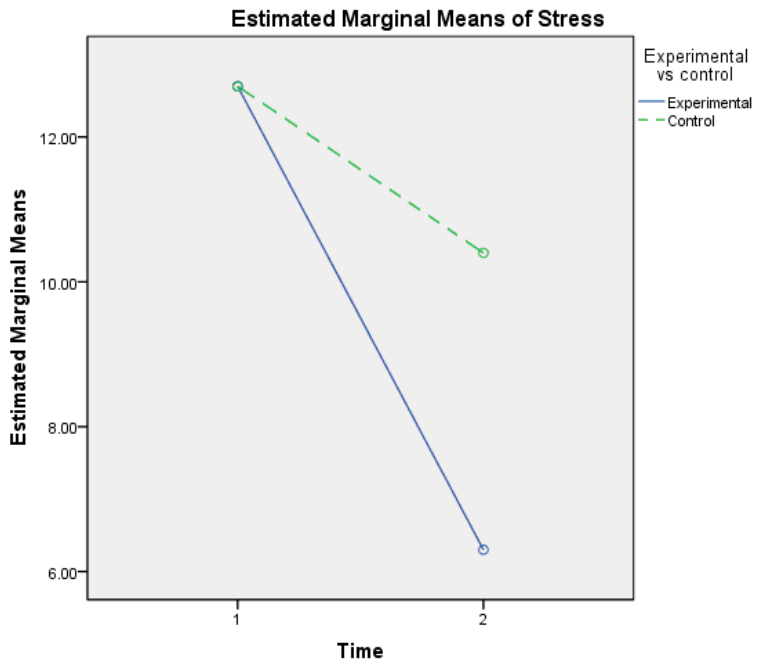


*Figure 2*. Line graph depicting the results of the ANOVA for group and time on stress.

## Memory

To test hypothesis number two, a 2x2 mixed-groups factorial analysis of variance was performed to examine the effects of relaxation intervention on short-term memory test scores (see Figure 3). The analysis exhibited an increase in the experimental group's memory scores from the pre-test (M = 17.9, SD = 3.99) to the post-test (M = 19.75, SD = 4.1) while the control group's memory scores slightly decreased from the pre-test (M = 18.8, SD = 3.44) to the post-test (M = 18.15, SD = 3.03). The results exhibited no statistically significant main effect for time with $F(1,38) = 11.69$, $p = .109$ nor any main effect of group, $F(1,38) = .101$, $p = .752$. There was a statistically significant interaction between group and time, $F(1,38) = 11.69$, $p < .05$.

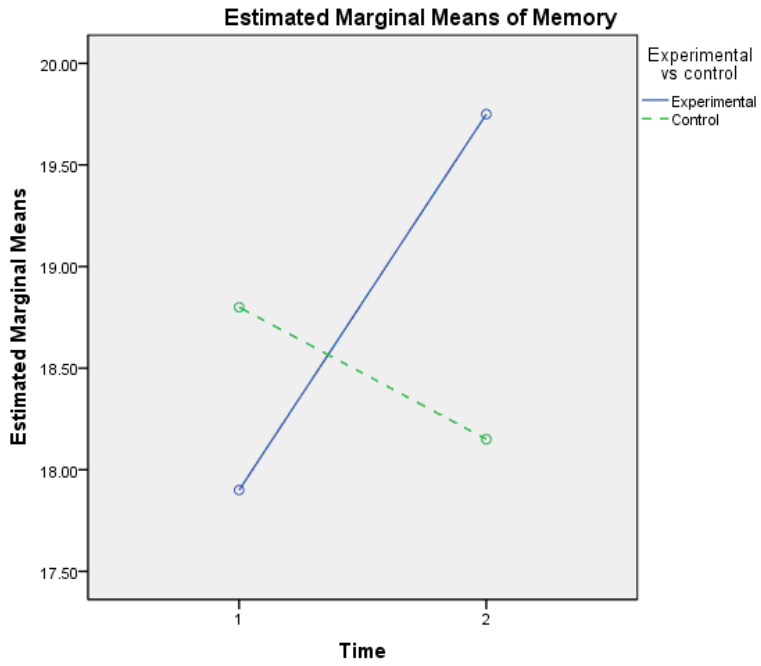


*Figure 3*. Line graph depicting the results of the ANOVA for group and time on memory.

## Attention

To test hypothesis number three, a 2x2 mixed-groups factorial analysis of variance was performed to examine the effects of relaxation intervention on sustained and selective attention (see Figure 4). The results exhibited an increase in attention scores of the experimental group, from before the intervention (M = 90.35, SD = 30.15) to after the intervention (M = 99.05, SD = 16.88). On the other hand, for the control group, attention scores slightly decreased from the pre-test (M = 98, SD = 14.5) to the post-test (M = 96.4, SD = 21.63). There were no statistically significant results for main effect of time with F (1,38)= 1.31, p = .260 or main effect of group, F (1,38)=. 17, p = .684. Similarly, there were no statistically significant results for the interaction between group and time, F (1,38) = 2.75, p = .105.

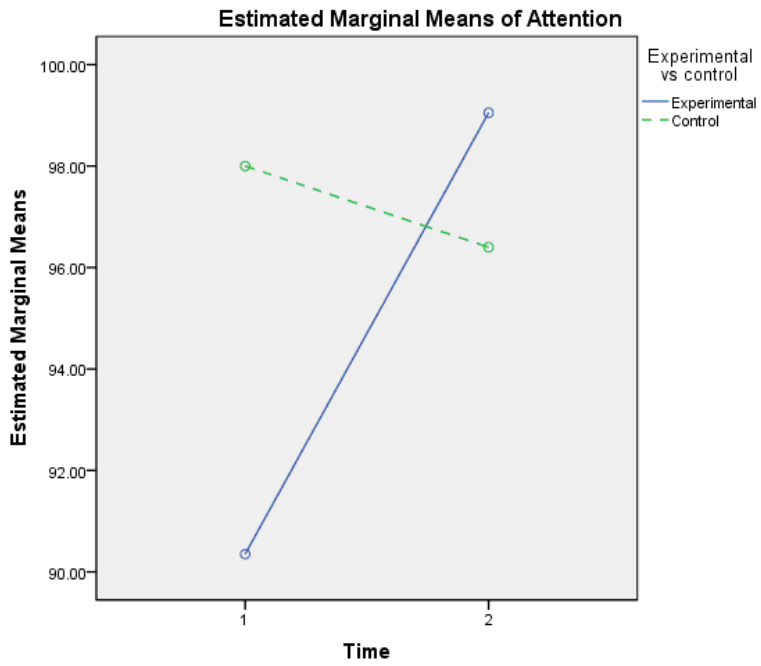


*Figure 4*. Line graph depicting the results of the ANOVA for group and time on memory.

## Discussion

It has been documented that relaxation techniques in general can be equally effective with other techniques used by professionals in reducing the symptoms of stress. In our study we tried to examine the effects of a relaxation technique on individual's perceived stress levels and cognitive performance.

Our findings seem to support other scientist's previous findings, exhibiting that relaxation techniques can successfully reduce stress and increase feelings of calmness and relaxation. According to our results, we see a main effect where both experimental and control group's stress levels decreased substantially from pre- measurements to post- measurements. Moreover, although there was no statistically significant main effect for group we observe that the experimental group's stress levels were reduced more than the control group. Furthermore, the interaction effect exhibits that the experimental group experienced the highest amount of stress reduction out of the other four conditions. The reason of the small difference in stress reduction scores between the experimental and control group might be due to the fact that the duration of

the preferable intervention was only approximately ten minutes. Therefore, perhaps the relaxation time wasn't enough to give us significant results. Moreover, the finding that the control group's stress levels were reduced from pre- test to post- test might be due to the fact that, participants, and especially the ones from the control group, felt boredom and tiredness through the procedure according to participant self-reports after the whole experiment.

Concerning our findings on memory we observe that there's no main effect since we didn't find any significant difference neither from pre- test to post-test nor from experimental group to the control one. Nevertheless, we observed a statistically significant interaction effect where the experimental group exhibited a notable increase in memory scores from pre to post-measures compared to the control group that showed a slight decrease from pre to post-measures. The fact that we didn't have any main effect might again be due to short duration of the intervention but still even here we see from the produced interaction effect, that our hypothesis was supported. Since both group's stress levels were decreased, it was expected in accordance to our hypothesis, that both group's memory scores would increase. However, we observed an increase in the experimental group's memory scores compared to a slight decrease of control group's memory scores. This reduction in stress while its beneficial effects remain (improved memory scores), in accordance to previous research, might indicate that by using a meditation- relaxation technique short-term memory can be improved.

Furthermore, regarding attention although there was no statistical significance the results exhibited a decrease on the attention scores of the control group while there was a notable increase on the attention scores of the experimental group. The score differences between the two groups follow the same direction of our hypothesis but still the difference between post measures of the groups was too small. Perhaps, from these last findings we can hypothesize that maybe the attention task was to easy, not allowing us to find significant differences between the experimental and the control group's scores.

In regards to generalizability of this study, due to the fact that the experimenter's sample consisted of only women with a certain age span, it would be hard to generalize these results for the rest of the population. Furthermore, the study concerns only students, which is another

indication that generalizability of the results might be limited. However, the findings of this study aims to provide people with alternative ways of relaxation, which will hopefully lead to the avoidance of external of external aids such as medication and also to money saving. The particularity of this technique is that everybody can practice the intervention as it is at private and public locations or to alternate components like music in a way that it would be more suitable to their personal needs.

Moreover, the are some limitations concerning this study and one of them is generalizability, as previously mentioned, since the sample consisted only of women with an age span from twenty to thirty years old. Additionally, perhaps a stronger effect of relaxation would have been observed if the participants had been subjected to a controlled stressor immediately prior to the present experiment. Especially considering that in this study, self-rated stress levels were rather low in both groups at baseline (12.7 on the scale 0-30).

Concerning the participants' division in groups for the experimental and control procedures, it would be appropriate to mention that the experimenter was not blinded regarding the placement of the participants, which could have resulted to experimenter bias.

Additionally, maybe it would have been better if the pre- post measurements had been separated in two different days or if experimental group's participants had practice the relaxation technique sometime before the experiment. In other studies the relaxation technique required at least some days of training, where the individual was taught the ways to recognize stressors and the ways to deal with them.

The strengths of our research are the standardization of the methods, more specifically the recording of the music and the relaxation instructions as a unified relaxation method. Similarly, it is important to mention that the type of our intervention is relatively novel compared to previous relaxation techniques used in other studies.

Regarding reliability and validity we could say that since our findings concerning stress reduction with the use of relaxation techniques agree also with previous researches then this

indicates that the chosen method can be consider as valid and reliable when it comes to stress reduction. Regarding validity it seems that our variables reflect accurately what the experimenter wanted to measure as all of the scales and tests used are considered as standardized from previous research.

Researchers have mentioned the term, cortisol reactivity which means that not all stressed individuals exhibit the same amounts of cortisol. More specifically studies examining gender differences on stress induced symptoms or even on memory have concluded to the fact that women get more stressed than men even under the same circumstances, which is an indication that their cortisol levels are higher than men during the same stressful situation (Matud, 2004). Therefore regarding individual differences it would be logical to hypothesize that cortisol levels induced by stress might differ for every individual. Besides, this could explain the reason that stress might be beneficial for some people although for others not.

Additionally, there are many additional factors and psychological determinants that could affect how an organism reacts to stressor. One of them can be also the individual's perception or beliefs about a stressor (e.g. does the individual has enough self- confidence to deal with the stressor or not?). Therefore it would be rational to think that perhaps different interpretation of the stressful events will result to less bodily reactions or somatic symptoms.

Researchers supported that when stress exists in certain levels it can help in preparing body and mind for action (enhanced memory, increased heart rate, focused attention) although in higher levels stress may impact cognitive functioning (McEwen & Sapolsky, 1995). So we conclude that in a way we can regulate stress. There are individuals that although stressed, they still are cognitively and physically productive and they still score high in memory and attention only because of their ability to regulate the negative effects of stress while keeping the beneficial one's. Our meditation- relaxation technique managed successfully to demonstrate this effect, when although stress decreased memory increased for the experimental group. However maybe it would be better if a stressor was present in our experiment, because then we might have seen bigger differences between the scores of the groups. In addition, since literature has shown that there are gender differences on stress levels, a good suggestion for further research based on this

experiment would be also the addition of gender variable as well. In the present study although we were aware of possible gender differences in the effects of relaxation training on perceived stress and cognitive performance, we decided no to focus on gender in terms of easier randomization.

Considering all the above we realize that stress depends on many factors and although it would be impossible to avoid stressors completely, still there are several relaxation techniques for minimizing the negative effects of stress while preserving the ones that promote our cognitive performance. The relaxation technique of our selection seems to be one of them.

**References**

Bohnen, N., Houx, P., Nicolson, N., & Jolles, J. (1990). Cortisol reactivity and cognitive performance in a continuous mental task paradigm. *Biological Psychology*, 31(2), 107-116

Buchanan, T. W., Tranel, D., & Adolphs, R. (2006). Impaired memory retrieval correlates with individual differences in cortisol response but not autonomic response. *Learning & Memory*, 13(3), 382-387.

Dendato, K. M., & Diener, D. (1986). Effectiveness of cognitive/relaxation therapy and study-skills training in reducing self-reported anxiety and improving the academic performance of test-anxious students. *Journal Of Counseling Psychology*, 33(2), 131-135.

Davis, M., Eshelman, E. R., & Mc Kay, M. (2013). *The relaxation and stress reduction*. Retrieved from

http://www.scribd.com/doc/137313174/The-Relaxation-and-Stress-Reduction-Workbook.

Elzinga, B. M., & Roelofs, K. (2005). Cortisol-Induced Impairments of Working Memory Require Acute Sympathetic Activation. *Behavioral Neuroscience*, 119(1), 98-103.

Findlow, W., Price J., Hochhalter, A. E., Laditka, A. K., James, N. (2010), Primary care providers sources and preferences for cognitive health information in the United States. *Health promotion international*, 25, 464- 473, Oxford University Press.

Galvin, J. A., Benson, H., Deckro, G. R., Fricchione, G. L., & Dusek, J. A. (2006). The relaxation response: Reducing stress and improving cognition in healthy aging adults. *Complementary Therapies in Clinical Practice*, 12, 186-191.

George, E. M., & Coch, D. (2011). Music training and working memory: An ERP study. *Neuropsychologia*, 49(5), 1083-1094.

Guenzel, F. M., Wolf, O. T., & Schwabe, L. (2013). Stress disrupts response memory retrieval. *Psychoneuroendocrinology*, 38(8), 1460-1465.

Jiang, J., Zhou, L., Rickson, D., & Jiang, C. (2013). The effects of sedative and stimulative music on stress reduction depend on music preference. *The Arts In Psychotherapy*, 40(2), 201-205.

Kaspereen, D. (2012). Relaxation intervention for stress reduction among teachers and staff. *International Journal Of Stress Management*, 19(3), 238-250.

Kirschbaum, C. C., Wolf, O. T., May, M. M., Wippich, W. W., & Hellhammer, D. H. (1996). Stress- and treatment-induced elevations of cortisol levels associated with impaired declarative memory in healthy adults. *Life Sciences*, 58(17)

Kuhlmann, S., Piel, M., & Wolf, O. T. (2005). Impaired Memory Retrieval after Psychosocial Stress in Healthy Young Men. *The Journal Of Neuroscience*, 25(11), 2977-2982.

Labbé, E., Schmidt, N., Babin, J., & Pharr, M. (2007). Coping with stress: The effectiveness of different types of music. *Applied Psychophysiology And Biofeedback*, 32(3-4), 163-168.

Lingham, J., & Theorell, T. (2009). Self-selected 'favourite' stimulative and sedative music listening—how does familiar and preferred music listening affect the body?. *Nordic Journal Of Music Therapy*, 18(2), 150-166.

Liston, C. C., McEwen, B. S., & Casey, B. J. (2009). Psychosocial stress reversibly disrupts prefrontal processing and attentional control. *PNAS Proceedings Of The National Academy Of Sciences Of The United States Of America*, 106(3), 912-917.

Lupien, S. J., Maheu, F., Tu, M., Fiocco, A., & Schramek, T. E. (2007). The effects of stress and stress hormones on human cognition: Implications for the field of brain and cognition. *Brain And Cognition*, 65(3), 209-237.

Matud, M. P. (2004). Gender differences in stress and coping styles. *Personality and individual differences*, 37(7), 1401-1415.

McEwen, B. S., & Sapolsky, R. M. (1995). Stress and cognitive function. *Current Opinion in Neurobiology,* 5, 205-216.

Mohan, A., Sharma, R., & Bijlani, R. L. (2011). Effect of meditation on stress-induced changes in cognitive functions. *The Journal Of Alternative And Complementary Medicine*, 17(3), 207-212.

Morrison, F. J., & Lindsay, W. R. (1997). Reductions in self-assessed anxiety and concurrent improvement in cognitive performance in adults who have moderate intellectual disabilities. *Journal Of Applied Research In Intellectual Disabilities*, 10(1), 33-40.

Quick, J. C., Quick, J. D., Nelson, D. L., & Hurrell, J. J. (1997). *Preventive stress management in organizations.* Washington, DC: American Psychological Association.

Roden, I., Grube, D., Bongard, S., & Kreutz, G. (2014). Does music training enhance working memory performance? Findings from a quasi-experimental longitudinal study. *Psychology Of Music*, 42(2), 284-298.

Tang, Y., Ma, Y., Wang, J., Fan, Y., Feng, S., Lu, Q., & ... Posner, M. I. (2007). Short-term meditation training improves attention and self-regulation. *PNAS Proceedings Of The National Academy Of Sciences Of The United States Of America*, 104(43), 17152-17156.

Thoma, M. V., la Marca, R., Brönnimann, R., Finkel, L., Ehlert, U., & Nater, U. M. (2013). The effect of music on the human stress response. *Plos ONE*, 8(8),

Sandford, J. A., & Turner, A. (2005). Integrated visual and auditory continuous performance test: Administration Manual. Brain Train, Inc.

Sandford, J. A., & Turner, A. (2004). Integrated visual and auditory continuous performance test: Interpretation Manual. Brain Train, Inc.

Schoofs, D., Pabst, S., Brand, M., & Wolf, O. T. (2013). Working memory is differentially affected by stress in men and women. *Behavioural Brain Research*, 241144-153.

Vedhara, K., Hyde, J., Gilchrist, I. D., Tytherleigh, M., & Plummer, S. (2000). Acute stress, memory, attention and cortisol. *Psychoneuroendocrinology*, 25(6), 535-549.