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Katie Miller will graduate from UW Oshkosh in May 2009 with a degree in psychology and a minor in neuroscience. Her introduction to research began with an experimental psychology course in spring 2007, and she is now assisting Dr. David Lishner and Dr. Phan Hong of the UW Oshkosh psychology department with their research. Katie is interested in clinical psychology, and she hopes to pursue further study in the field after graduating.

Christina Brazeau is a senior majoring in psychology at UW Oshkosh. Behavioral psychology with an emphasis in child behavior is her field of interest. She is aspiring to work in a clinical setting, counseling adolescents and young adults. When she is not studying, she enjoys spending time with her son and husband, volunteering, watching movies, and playing a variety of sports.

Melissa Fuiten graduated from UW Oshkosh in December 2007 with a bachelor's degree in psychology. She is now pursuing a bachelor's degree in nursing from UW Oshkosh and will graduate from the program in May 2010. Her career goal is to gain employment at Children's Hospital in Milwaukee as a pediatric nurse and child life specialist. She believes that through compassionate caring she can make an immense difference in the lives of children.

Jessica Woelfel will graduate from UW Oshkosh in May 2008 with a Bachelor of Arts degree in psychology. She plans to continue her schooling at Edgewood College in Madison by pursuing a Masters of Science degree in marriage and family therapy.

Tammy Kadah-Ammeter, a UW Fox Valley alumna, received her M.S. in experimental psychology from UW Oshkosh in 2005, followed by appointments at Fox Valley Technical College, UW Oshkosh, and UW Fox Valley. She teaches courses in introductory psychology, life span developmental psychology, experimental psychology, statistical methods in psychology, psychology of adulthood and aging, cognitive psychology, and psychology of human relations. Her background is in experimental and cross-cultural psychology, with a focus on the way we see ourselves in relation to others, or self-construal. Her primary research emphasis examines the potential for priming to affect self-construal scale scores.

Abstract

This study based its method on Pitzen and Rauscher's 1998 study, testing 60 participants between classical stimulative, sedative, or no music conditions and choice or no choice exposure conditions. We calculated results using two 2 X 3 design (Condition X Music) completely randomized factorial analyses of variance for mean difference of heart-rate (HR) before and after the exposure condition and

for state anxiety, a short-term form of anxiety. Findings indicated that mean HR difference increased in the no choice condition compared to the choice. Participants scored significantly higher state anxiety for choice-stimulative as compared to the no choice-stimulative condition. Additionally, participants in the no choice-no music condition showed significantly higher state anxiety compared to those in the no choice-stimulative condition. For future research, experimenters may include the skin conductive measure galvanic skin response (GSR) as a second dependent variable. Finally, participants could wait 5 to 10 min in order to acclimate to the testing environment.

Numerous studies have looked at physiological arousal, particularly its causes and effects. Some of this research has discovered a link between arousal and memory facilitation. Quas and Lench (2007) found an association in children between higher HR at the time of encoding memory and fewer errors on a memory test. Similarly, Field, Rickard, Toukhsati, and Gibbs (2007) found that the release of norepinephrine in the state of physiological arousal facilitated learning in young chicks.

Given this effect of arousal on memory facilitation, research on the effects of exposure conditions on arousal levels produced mixed results. Pitzen and Rauscher (1998) found that 8 min of the no music exposure condition resulted in higher GSR, which measures skin conductance in response to stress, than the no choice or choice music conditions. The study also found that the choice exposure condition, when varied across different genres of music (jazz, classical, techno, and folk), resulted in significantly lower GSR. In terms of HR, there was no difference between listening conditions. This finding indicates that choice listening conditions can result in lower arousal. Also, exposure to music despite no choice or choice listening conditions is less arousing than being in silence.

In contrast to this finding, however, Hirokawa (2004) measured arousal levels using Thayer's Activation-Deactivation Adjective Check List (1978) after subjects listened to 10 min of subject-preferred music, relaxation instructions, or silence. Results indicated that silence increased the participants' tiredness and calmness levels. Music also increased subjects' energy levels, and relaxation and silence significantly decreased them. This discrepancy could have occurred because Hirokawa (2004) had longer listening conditions and looked at older adults as opposed to college students. The study also found that subject-preferred music was potentially able to reduce the tension subcategory of arousal in older adults. Therefore, being able to listen to music that one chooses could result in lower levels of physiological arousal.

Existing research on stimulating versus sedative music and arousal levels is also conflicting. Smith and Morris (1976) had students listen to stimulative, sedative, or no music while taking a course exam and, as they were taking the exam, fill out a questionnaire five times that was designed to measure the students' worry about the test, arousal, concentration ability, performance expectancy, and like or dislike of the music. This study found that stimulating music significantly increased both worry and emotion, while sedative music had no effect on anxiety compared to the control group.

Rohner and Miller (1980) examined the effect that familiar music, varying in terms of familiarity and stimulating or sedative, had on a participant pertaining to

state anxiety. State anxiety, a short-term form of anxiety, is a condition that a person experiences at a certain moment. This is opposed to trait anxiety, which is a more permanent personality feature. The study used five levels of music treatment: familiar-stimulating, familiar-sedative, unfamiliar-stimulating, unfamiliar-sedative, and no music. Results for this study implied that music had no reducing effect on state anxiety. Smith and Morris (1976) may have found differences in arousal caused by sedative and stimulative music because they had their participants take a course examination during the listening conditions, a factor that may have resulted in their having higher anxiety than the participants who were not taking an exam in the study by Rohner and Miller (1980).

In our study, we used HR and state anxiety as dependent measures. Various studies have tried to find the relationship between psychological self-report measures, such as state anxiety, and physiological measures of anxiety, such as HR, with mixed results. For instance, De Jong, Moser, An, and Chung (2004) did not find any correlation between state anxiety and HR in acutely ill cardiac patients. However, Tenenbaum and Milgram (1978) found a correlation between state anxiety and HR in Israeli student athletes. Similarly, Kantor, Endler, Heslegrave, and Kocovski (2001) found that a self-report measure of state anxiety significantly related to HR during a stressful situation.

In this study, we examined the effects that listening to stimulative, sedative, or no music in choice or no choice exposure conditions have on physiological arousal. Previous studies, including Pitzen and Rauscher's (1998), looked at effects on arousal with more than one genre of music and more than one musical selection for each genre. We examined only the classical music genre and offered participants one musical selection for each music condition (sedative, stimulative, or no music). Because of the link between arousal and memory, the study could have implications for learning, such as which music to listen to while studying or whether having the option of choosing to hear certain music will assist the learning process. We considered the following hypotheses:

Heart Rate

Hypothesis 1: Hirokawa (2004) found implications for reducing the tension subcategory of arousal with subject-preferred music. Therefore, we hypothesized that participants in the no choice condition would have a higher mean difference between HR before and after the exposure condition than those in the choice condition.

Hypothesis 2: Because Pitzen and Rauscher (1998) found no difference in mean HR between music conditions, there would be no mean HR difference between music conditions (sedative and no music, stimulative and no music, and stimulative and sedative).

Hypothesis 3: Hirokawa (2004) found that silent listening conditions increased relaxation, so participants who chose no music would have the lowest mean HR difference compared to all other conditions.

State Anxiety Inventory (STAI)

Hypothesis 4: We predicted that participants in the no choice condition would have higher HR. Previous studies (Kantor et al., 2001; Tenenbaum & Milgram, 1978)

linked high HR to high state anxiety, so participants in the no choice condition would have higher state anxiety scores than those in the choice condition.

Hypothesis 5: Smith and Morris (1976) found that stimulative music increased worry and anxiety. Therefore, participants in the stimulative music condition would have higher state anxiety scores than those in the sedative and no music conditions, respectively.

Hypothesis 6: With the above reasoning, participants in the no choice-stimulative condition would have the highest state anxiety scores overall.

Method

Participants

Sixty UW Oshkosh undergraduate students (ages 18 to 30) of mixed race, ethnicity, and gender participated in this experiment. The participants were either fulfilling a course requirement or earning extra credit. We recruited them from Sona Systems™, an online participant pool Web site used through the UW Oshkosh psychology department. Participants were treated in accordance with the "Ethical Principles of Psychologists and Code of Conduct" (American Psychological Association, 1992).

Apparatus/Materials

The apparatus/materials used in this study consisted of a stimulating classical music selection (choice A), a sedative classical musical selection (choice B), a compact disc Sony® ESP-MAX CD Walkman® CD-R/RW with a model number of D-E356CK, Sony® headphones with model number MDR-G52, a watertight model 266 Sportline® stopwatch, the STAI (Spielberger and Reheiser 2004), and a demographic and music preference survey that we created. For the stimulative music selection (choice A), we used "Allegro con fuoco" by Piotr Tchaikovsky from the Manfred Symphony Op. 58, taken from the study by Pitzen and Rauscher (1998). For the sedative classical music selection (choice B), we used "The Swan of Tuonela" by Jean Sibelius, which was from the study by Rohner and Miller (1980).

We did not place headphones on the participants in the control group who were not exposed to music. We took the HR (pulse) of the participants for 1 min for three different times throughout the experiment using our hands because we were unable to find HR measuring devices such as finger HR monitors. Using the stopwatch, we took the participants' HR for 1 min at three different times during the experiment.

The STAI consisted of 40 questions that determined how the participants felt at the time. On the STAI, participants agreed or disagreed with statements such as "I feel calm" and "I lack self-confidence." The experimenters also devised a demographic and music preference survey that consisted of 32 questions to help determine participants' personal experience with and preference for music as well as familiarity with the piece they had heard if they were in either of the two music conditions. The demographic and music preference survey asked participants to agree or disagree with statements such as "I prefer to listen to classical music" and "I prefer to listen to music with lyrics."

Procedure

After obtaining informed consent, we randomly assigned the participants to either a no choice or a choice condition. If the participants were randomly assigned to a no choice condition, we also randomly assigned the participants to listen to either choice A, choice B, or no musical selection. If the participants were randomly assigned to a choice condition, the participants were given the option to listen to choice A, choice B, or no musical selection.

Next, we issued the instructions for the participants to read before they participated in the study. The instructions were slightly different for participants depending on whether they were randomly assigned to the no choice or choice condition and whether they were in the control group. We told participants in the music conditions to sit and listen closely to the music, and participants in the no music condition to sit quietly for 4 min; except for a table and a chair, the testing room was empty so that they would not be distracted. We then took and recorded the participants' pulses using a stopwatch to time for 1 min.

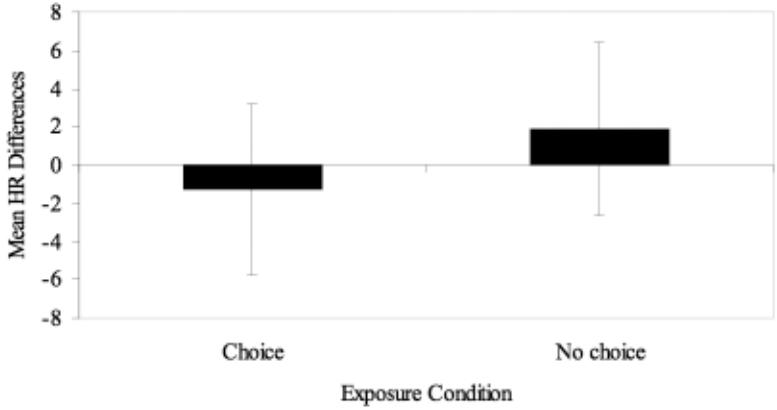
The participants then listened to one of the two musical selections or no musical selection at all, which either the participant or we had chosen, for 4 min using a compact disc Walkman® and headphones. We took the participants' pulses for a second time using the first method. The experimenters next issued the participants the STAI. After they had filled out the STAI, we issued a demographic and music preference survey. In order to ensure that there were no lasting effects from the music or silence, we took the participants' pulses for a third time. Finally, we debriefed the participants by explaining the purpose of the study, the condition to which the participants were assigned, and the benefits of the research to psychological knowledge. If the participant had any questions, we answered them forthrightly.

Results

Heart Rate

We calculated the mean differences between the HR baseline and after the exposure condition using a 2 X 3 design (Condition X Music) and two completely randomized factorial analyses of variance, one within-subjects and one between-subjects. All statistics used an alpha level of .05 (alpha level is used to determine whether the *p* value found in the statistical tests is significant; the odds that the observed result was due to chance). Overall, participants in the no choice condition experienced an increase between the first HR taken and the second HR taken (after the exposure condition). The choice condition experienced an overall decrease in mean HR difference. Participants in the no choice condition ($M = 1.9$, $SD = 4.5$) showed a significantly higher variation in mean HR difference compared to those in the choice condition ($M = -1.26$, $SD = 4.5$), $F(1, 58) = 6.31$, $p < .05$ (see Figure 1). The no music condition showed the highest increase in mean HR difference; sedative music was neutral, and stimulative music showed a decrease in regard to mean HR difference.

Figure 1
Main Effect of Exposure Condition for Mean Difference of HR



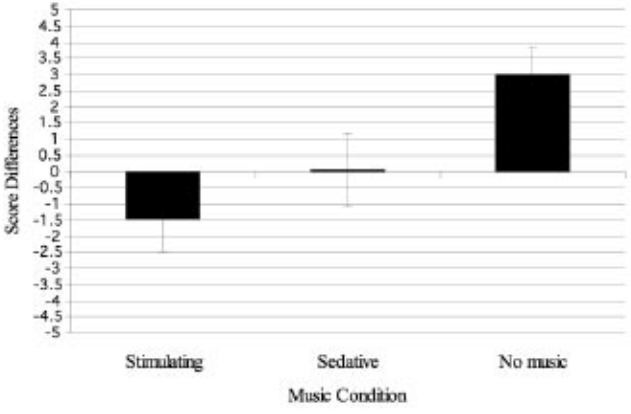
Note. Participants in the no choice condition (M = 1.9, SD = 4.5) showed a significantly higher difference in HR (baseline to music), compared to choice condition (M = -1.26, SD = 4.5), $F(1, 58) = 6.31$, $p < .05$. Lines on bars indicate SD* of ± 1 SE**.

*Standard Deviation (SD) basically tells how far or close the scores are from the mean of a set of data.

**Standard Error (SE) measures the standard amount of difference between the sample mean and the population mean that one can expect by chance.

As seen in Figure 2, there was an overall main effect for music condition (M = .31, SE = 6.1), $F(2, 58) = 4.33$, $p < .05$. A Scheffé comparison showed that stimulative music (M = -1.47, SE = 1) had a statistically significant lower mean HR difference compared to no music (M = 3, SE=.84), $F(2, 58) = 4.34$, $p < .05$. We found no significant disparity between stimulative and sedative music, or sedative and no music, or in mean HR differences between music and survey readings, or base and survey readings. We also did not find any interactions between condition and music in regard to the difference in HR.

Figure 2
Main Effect for Music Condition



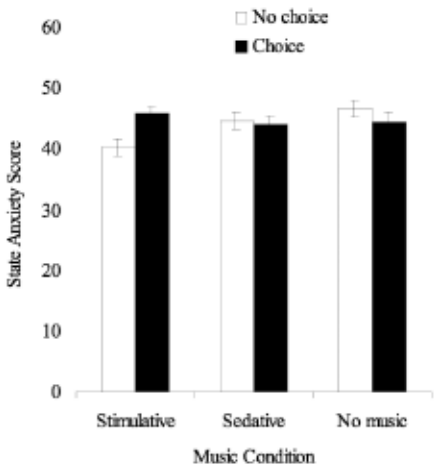
Note. Main effect for music condition (M = .31, SE= .61), $F(2, 58) = 4.33$, $p < .05$. Scheffé comparison showed stimulative music (M = -1.47, SE = *1*) had statistically significant lower HR differences than no music (M = 3, SE = *.84*), $F(2, 58) = 4.34$, $p < .05$. Lines on bars indicate SE of ± 1 SE.

State Anxiety

Using a 2 X 3 design (Condition X Music), we analyzed the mean scores for the state anxiety survey using a between-subjects completely randomized factorial analysis of variance. Participants in the no choice-no music condition demonstrated higher levels of state anxiety. Those in the no choice-stimulative condition had the lowest state anxiety scores. State anxiety scores increased in sedative music and were highest in the no music level for the no choice condition.

Choice-condition participants showed a small decrease in state anxiety over stimulative, sedative, and no music levels, with no music being lowest in choice condition. There were no main effects found for exposure condition or music condition. Overall, participants in the no choice condition had lower state anxiety than those in the choice condition, but these differences were not significant. Participants in the stimulative music condition scored lower for state anxiety as opposed to sedative and no music, respectively. However, a significant interaction was found between condition and music type $F(2, 54) = 4.36$, $p < .05$ (see Figure 3). The Scheffé comparisons showed that the choice-stimulative condition ($M = 45.75$, $SE = 1.27$) was significantly higher than no choice-stimulative ($M = 40.2$, $SE = 1.39$). The no choice-stimulative condition ($M = 40.2$, $SE = 1.39$) was significantly lower than the no choice-no music condition ($M = 46.7$, $SE = 1.39$), $F(2, 54) = 4.36$, $p < .05$.

Figure 3
Interaction of Condition and Level for State Anxiety Score



Note. Lines on bars indicate *SD* of ± 1 *SD*.

Discussion

Our results did not support the Pitzen and Rauscher (1998) study because we found significance for mean HR difference between music levels in the no choice and choice groups, whereas the Pitzen and Rauscher study did not find significant variation in HR between music levels. The data obtained in the current study also did not support

the Hirokawa (2004) study, which found that subject-preferred music has the potential to increase older adults' arousal; in the current study, participants who chose their music condition had higher state anxiety scores and a decrease in mean HR difference than those in the no choice condition. The current study, however, used young adults, which may account for the differences found.

In effect, we found it interesting that participants in the stimulative music condition had high state anxiety scores but a decrease in mean HR difference. This difference is not entirely surprising because of the varied research on the relationship between physiological and psychological measures, even though some studies have linked the two. The difference between HR and state anxiety scores in the current study could be due to the STAI being a self-reported measure; participants may not have been truthful while filling out the questionnaire or perhaps did not take the time to reflect on and answer the questions accurately.

During testing, we discovered several problems with the current study. The first pertained to taking the participants' HR. The experimenters took participants' HR for 1 min three times throughout the experiment, but there were other methods available, such as taking HR for 15 s and multiplying it by 4, or taking HR for 30 s and multiplying it by two. Since there was no conclusive information about which method was most accurate, experimenters had to choose one method over the others, and this could have altered results because participants' HR could have been lower or higher when taken with one method than with another.

Also, when many participants arrived for the study they were out of breath; some were freshmen who had gotten lost trying to find the experimenting room or were running late. Either way, for these participants, the first HR measurement would have been higher than average and established an unreliable baseline. Conversely, other participants arrived early and had time to sit and relax before having their baseline HR taken.

Because of these problems associated with taking HR, many of the previous studies employed other dependent variables to measure arousal levels, such as GSR. We considered using GSR to measure arousal level in addition to HR but, due to time limits, decided against it. GSR might have been a more accurate measure of participant arousal levels, and thus had it been used the data might have turned out differently. Researchers who wish to examine the relevance of no choice and choice exposure conditions and music conditions on physiological arousal levels should consider using medical equipment to take HR and employ GSR as a dependent variable.

Additionally, participants in the no music condition were possibly more likely to think about other topics during the 4 min of silence; anxiety caused by these thoughts would not have been due to the independent variables of the listening or the exposure condition and therefore would result in an internal validity problem. This discrepancy might account for the higher state anxiety scores in the choice-no music condition than in the no choice-stimulative condition.

The results of the study achieved our purpose, which was to demonstrate that a no choice music condition would cause higher levels of physiological arousal than a chosen music condition. Also, because physiological arousal is a process involved in learning, the current study's findings had a bearing on practical applications for study habits. Results showed that participants in the no music condition had the highest

arousal level, but also experienced the highest level of anxiety, respectively. Future research could test the effects of silence using a learning task.

This particular finding also has implications for relaxation methods because the highest arousal levels in the no music condition indicate that it is more relaxing to listen to music than to sit in silence. Also relating to relaxation, the no choice-stimulative condition had higher arousal levels than those in the choice-stimulative condition. This result suggests that if people wish to relax, it would be more beneficial to let them choose the music they would like to listen to, rather than forcing them to do so.

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