The Interaction between Music and Task Performance: The Tower of Hanoi & Missionaries and Cannibals

Honors Project

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ABASTRACT

This study investigated music and problem solving abilities. Two tasks were given, the Tower of Hanoi and Missionaries & Cannibals. The participants were exposed to rap music, country music, or no music at all. It was predicted that familiarity with the song would influence problem-solving abilities.

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Music has always been an intricate component in life, and can greatly influence an individual's ability to perform a given task, whether positively or negatively. It is hard to imagine a world where music is not present in simple, mundane activities i.e. household chores, driving, eating, social gatherings, etc. There is a decent amount of literature pertaining to music; however, much of it is based in industrial/organizational psychology. However, there has been little research on music and its influence on task performance. This study hopes to shed light on the debate of whether there is affect between the two.

North and Hargreaves (1999) concluded that while completing a certain task, in this case, a driving simulation, a liking for the music was positively related to task performance. Also within the study, evidence suggested that satisfaction with the task was directly related to music preference. If the individual liked the song while they participated in the simulation, satisfaction went up, and vice versa. This finding of musical preference and task performance strengthens past research, which argues that there is a relationship between satisfaction of a particular task and musical preference. Unfamiliarity or dislike for a particular genre of music can shift as suggested by Krugman (1943). Krugman administered a pretest and a posttest questionnaire concerning musical preferences and argued that mere exposure to a particular type of music could shift an individual's satisfaction of a particular music from negative to positive. By playing classical musical as well as swing music once a week for eight weeks to test subjects (7), results did infact imply that in spite of one's particular taste in music, "shifts in the direction of greater pleasantness preponderated over those in the direction of unpleasantness" (p.392).

Davidson and Powell (1986) found that easy-listening background music increased the time on a performance in a 5th grade classroom. Researchers also found evidence that suggested

that with background music, boys were more apt to continue with the task, yet the findings were not significant in regards to the girls due to a ceiling effect. Furthermore the study failed to specify if the results were generalizable to adults or anyone else and also failed to take into account the personality of each individual.

Furnham and Strbac (2002) argue that introverts would do worse on a task where there was music in the background. The study also argued that there would be no difference between introverts and extroverts completing the same task in the presence of silence. Evidence was found that the introverts did indeed perform worse in the presence of music on a reading comprehension test than the extroverts. Researchers suggested that the introverts had more difficult with reading comprehension because it was more cognitively complex than the other two tasks. Furnham and Allass (1999) concluded that music that is fast and familiar to the individual is considered more distracting then music that is not. Theses findings are contradictory North and Hargreaves (1999), who, which was discussed earlier, found that familiar music was not distracting, and actually had a positive influence on task performance. After an extensive review of the literature in the area of music on performance, evidence has not gone either way in proving its effects on performance.

The Tower of Hanoi (TOH) is an extraordinary tool in helping to understand how individuals process and complete tasks. By adding more coins or disks to the equation, the tower can become increasingly more difficult. There have been numerous studies that use the TOH to study ability to complete a complex task in both retarded and nonretarded individuals (e.g., Anderson & Douglass, 2001; Byrnes & Spitz, 1979; Spitz, Webster, & Borys, 1982). Byrnes and Spitz (1979) noted that for younger children, the tower of Hanoi only produced minor difficulties and it was the initial first move where the tower consisted of three layers that they had made an error. Rönnlund, M., Lövdén, M., and Nilsson, L. G. (2001) had participants from 35-85

complete a 5-disk TOH and concluded that performance was related to age. The older the individual, the longer it took the individual to complete the task and the higher the rate of error. This demonstrated that that the TOH is age sensitive. The researchers suggested that the decrease in performance was due to age-related visuospatial impairment. Rönnlund et. al. also found that there were gender differences in performances; males were able to complete the TOH quicker than females. This is concurrent with past research that there are gender differences in performance on the TOH (Barker, 1997; Leòn-Carriòn, Morales, Forastero, & Domìnguez-Morales, 1991; Mataix-Cols & Bartrés-Faz, 2002).

After reviewing the literature, it has come to been seen that there have been few studies that combine the Tower of Hanoi task with some sort auditory stimuli. Moreover, there have been few studies that discuss and analyze the cognitive aspects of the TOH task. One such study, however, conducted by Zook, Davalos, DeLosh, & Davis (2004) were interested in how working memory, inhibition, and fluid intelligence and how they pertain to task completion, in this case, the Tower of Hanoi and the Tower of London. Researchers found that though the tasks are very similar to one another, performance was only moderately correlated with one another.

There has been much debate in the literature whether the TOH task relies either on visuospatial abilities or verbal abilities. Hadley, Capon, Copp and Harper (2002) found that the TOH task requires goal-oriented planning and decision-making, which suggests the subjects were relying on visuospatial abilities rather than verbal abilities. Furthermore, what makes the TOH task seem so difficult is that to be able to complete it correctly in the least amount of moves requires the participant to inhibit certain moves. Rather than a trial and error process, the participant must plan their moves accordingly. Therefore inhibition and working memory play critical roles in the TOH task. Contrary to this, Welsh, Satterlee-Cartmell, and Stine (1999) administered the TOH and the TOL, two measures of working memory, and two measures of

inhibition. Welsh et. al. found evidence that suggests that there was no correlation between performance on the TOH task and spatial abilities. Hadley et. al. criticizes Welsh et. al and claims that the task used to measure spatial working memory could easily be memorized both verbally as well as spatially.

By combining the TOH with background music that is familiar to the group, due to peer selection, the researcher hopes to obtain a better understanding of how people process a complex task with a possible distracter in the background. For the study, two tasks were used; the tower of Hanoi task and the missionaries and cannibals task. The participant listened to country music, rap music, or no music and the variables were counter balanced for validity. It was predicted that favored genre of music as well as familiarity with the songs would have an affect on the individual's ability to perform on the task.

Method

Subjects and Design

Sixteen undergraduate students enrolled in an introductory psychology course participated in the study and received course credit for their participation. The experiment was a 3(music: no music, country, rap) X 2(task: Tower of Hanoi and Missionaries & Cannibals) within-participant design and was counter-balanced for validity purposes. The researcher was interested in how long it took the subjects to complete each task, how many times the subjects had to restart each task, as well as the number of steps the subject took.

Materials

In regards to the TOH task, three coins were used. For the missionaries and cannibals task, six Legomen were used to simulate the missionaries and cannibals. To aid with the completion of the TOH task, three strips of tape were laid on the table, indicating where to stop and start. An X was marked on the tape to indicate the designated stopping point. For the

missionaries and cannibals, two strips of tape were laid horizontally to simulate the opposite sides of a riverbank. The subjects listened to an MP3 player with headphones while asked to complete the task, rather than surround sound. To keep track of the time, a digital watch, which also had the capabilities of being a stopwatch was used.

Procedure

The subjects were read the objectives for each task prior to the first time they were asked to complete it, and where also provided throughout the experiment the objectives of each task incase they had forgotten. The researcher observed the subjects while they completed the tasks and noted the amount of steps as well as number of times the participant started over. The subjects were allotted 10 minutes to complete each task, and once they believed they had completely the task correctly, they were asked to recreate it, so the researcher could verify that they had completely it correctly. Furthermore, when asked to recreate it, the subject was asked to turn the music off and the researcher stopped the time. If the subject was unable to recreate it, the researcher asked the participants to start over with the music, which then the researcher restarted the time After each trial where the participant listened to music, they were asked to fill out a questionnaire with how familiar they were with the songs they had listened to. After the experiment was over, the subject was then asked to fill out a demographic, which also asked them about their musical abilities.

Tasks

Missionaries and Cannibals

The first task the subjects where asked to complete was the missionaries and cannibals task. The missionaries and cannibal task consisted of six Legomen, where the missionaries consisted of three Legomen who wore orange and black vests. The cannibals consisted of three Legomen skeletons. The objective of the task is to get the missionaries and the cannibals safely

across the river. However, if the number of cannibals on either bank is greater than the number of missionaries at any time, the cannibals will devour the missionaries and you must restart the task. Furthermore, the boat cannot cross the river by itself with no one on board.

Tower of Hanoi

The Tower of Hanoi consisted of 3 coins; a quarter, a nickel, and a dime. The task of the group was to move the tower from the original point to a designated point. The two rules that must be observed to complete the tower are that the individual can only move one coin at a time, and at no time can the bigger coin be place upon a smaller coin. When conducted properly, the three-coin TOH can be completed in seven steps. The equation to determine the number of moves required to complete the task is $2^{(N)}$- 1 where n is the number of coins or disks.

Results

A repeated measures ANOVA was conducted on task complexity and music type. Results showed that for all dependent variables, there was not a significant result for music type or for the interaction. However, results did indicate a significant effect for task complexity on the dependent variables of start overs [F (1, 15) = 49.81, P <.05, η^2 = .77], steps to complete task [F (1, 15) = 39.74, P <.05, η^2 = .73], and time to complete the task [F (1, 15) = 86.62, P <.05, η^2 = .85]. No other differences existed among any demographic variables.

Discussion

The researcher predicted that favored genre of music as well as familiarity with the songs would have an affect on the individual's ability to perform on the task. However, the results did not support the hypothesis. These findings contradict what North and Hargreaves (1999) found; familiar music was not distracting, but actually had a positive influence on task performance. Due to having such a small sample size, it is very difficult to confirm what was found by Rönnlund, M., Lövdén, M., and Nilsson, L. G. (2001). There were however, significant results in

regards to task complexity and the dependent variables. The tasks varied on complexity, with the TOH requiring less mental capacity and therefore being the easier of the two tasks. Being the easier task, it is of no surprise that the participants were able to complete the TOH task quicker than the M & C task. Initially, many of the participants assumed the M & C task to be rather simple, however after having some time to think about it and work on it, they found it more difficult than they had initially perceived.

Another interesting point to note is that when the participants were asked to recreate the tasks, many of the participants recreated the tasks in a different way then they had initially completed them. For example, to complete the TOH correctly in the least amount of steps, it is important to move the dime all the way to the right first. Many participants moved the dime only one spot to the right, rather than all the way. Yet, when they recreated the task, the same participant would move the dime all the way to the right. This was concurrent with the Byrnes and Spitz (1979) study. Also noticed throughout the experiment were various responses to the tasks. Many participants began to become jittery, tense, and some even talked to themselves. Throughout the literature reviewed, there was no discussion about the participant's physical responses to the tasks, which could lead to future research.

There are numerous limitations that could have affected the study. One major limitation of the study was the sample was too small to look at individual differences within the data, i.e., demographic differences. It is difficult to make any assumptions or generalizations with such a small sample size. Another limitation to the study is the data collection process. The researcher sat and observed the participant and tallied the amount of moves the participants took. The researcher could have possibly over tallied or under tallied the amount of steps, thus having an impact on the results. To correct this for future research, the researcher could video tape the experiment or have another research in the room and both tallied the steps taken. Further

research on the topic of task performance and music could also include different genres of music. Perhaps the two genres of music in the study were not opposing enough to one another to cause some sort of variance. Also, rather than just having only two genres of music, researchers could use multiple genres to see if there are any particular genres that participants respond to more strongly. Though the hypothesis was not supported, results from the study hopefully will aid in generating new ideas to pursue for future research.

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