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A Cognitive Study of Multiple Genres of Music and their Effect on Problem Solving Ability

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Running Head: LISTENING TO MUSIC HINDERS TASK

Listening to Music Hinders the Ability to Complete a Novel Task

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Abstract

This study examined the effectiveness of music being a distracter while completing a novel special-temporal task. Sixty-four individuals participated in the experiment in which they assembled a jigsaw puzzle while being exposed to a randomly assigned audio stimulus: no music, soothing music, Mozart, or aggressive music. The primary hypothesis was that while listening to any music individuals would be distracted and thus take the longer to complete the jigsaw puzzle than the control group. The secondary hypothesis was that the aggressive group would be the most distracted by the music and thus take the longest to complete the task. The results did not support the primary hypothesis, but did show a strong trend toward its confirmation. The second hypothesis was supported. This suggests that music heard while completing a novel spatial-temporal task hinders the ability to complete that task and the severity of hindrance is effected by the style of music heard. Future research in this area could study the effects of music on the ability to complete tasks of varying difficulty and examine the effects of stress.

Listening to Music Hinders the Ability to Complete a Novel Task

Music is a large part of our daily life. We listen to music while completing many cognitive tasks – cleaning, driving, studying, even while we think. Some people enjoy loud music, while others enjoy music that is quiet. We are often subjected to music that we would prefer not to listen to, as when someone drives down the street with their car stereo blasting, or the next-door neighbor has his or her music so loud we can hear it a block away. A question arises about whether the genre of music we listen to, or are subjected to, distract us while completing other cognitive tasks. Distraction, in this study, is defined as the diversion of ones attention from one subject to something else. The question I ask is – does listening to music while completing another task have an adverse effect on our ability to complete that given tasks?

In 1993 Rauscher, Shaw, and Ky and then in 1995 Rauscher, Shaw, Levine, Ky, and Wright presented evidence for the enhancing effect of listening to music, specifically a piece by Mozart, prior to the completion of a task. This finding has now been dubbed the Mozart Effect. Nantais and Schellenberg (1999) state that the "Mozart Effect…indicates that spatial-temporal abilities are enhanced after listening to music composed by Mozart" (p. 370). Spatial-temporal reasoning is an individuals' ability to create, change, maintain, and relate complex mental images. This reasoning can occur even in the absence of external sensory input or feedback. Any time an individual thinks about a math problem without the use of pen and paper, puts a jigsaw puzzle together, draws an image from their memory, or even listens to or plays music, they are using spatial-temporal reasoning.

Rauscher et al. (1993) presented the results of the original experiment regarding the temporary increase in spatial intelligence scores of individuals that listened to Mozart's Sonata

for Two Pianos in D Major, K. 448. A total of 36 college undergraduates from the University of California, Irvine participated in the study. These participants were assigned to one of the following three groups: group one listened to Mozart's Sonata for Two Pianos in D Major, K. 448, group two listened to a "relaxation tape", and the final group listened to silence. Each group received the given stimulus for ten minutes. After the ten minutes of stimulus, participants were given a test that was designed to measure their spatial intelligence. The test, consisted of Paper Folding and Cutting, Pattern Analysis and Matrices, was three out of four sets that make up the Abstract/Visual Reasoning Area of the Stanford-Binet Intelligence Scale (Fudin and Lembessis, 2004) and test an individual's ability to mentally unfolding a piece of paper is that has been folded over several times and then cut. The object is to correctly select the final unfolded paper shape from five examples. The results of the experiment demonstrated that the participants in the study increased their mean spatial-temporal reasoning scores on portions of the Stanford-Binet Intelligence Scale: Fourth Edition about eight to nine IQ points after listening to the ten minutes of Mozart. The control group did not have this increase of IQ points.

A limitation was found with the results of the experiment; the increased IQ points were not long lasting; they disappeared after ten to fifteen minutes (Steele, Bass, and Crook, 1999). In 1998, Rauscher and Shaw reviewed their data from all of their experiments regarding the Mozart Effect and concluded that when comparing the successes and failures, the Mozart Effect was only obtained with spatial-temporal tasks, which are tasks that involve the mental transforming of stimulus, (examples are Paper Folding and Cutting, mental rotation tasks, and jigsaw puzzles) and not with spatial-temporal recognition, in which the individual searches for physical similarities among visually presented tasks, (an example is Raven's test) (Nantais & Schellenberg, 1999).

Since the report of the original finds by Rauscher et al. in 1993, many attempts to replicate their findings have been attempted, with mixed results. In 1999 Steele et al. set out to repeat the experiment conducted by Rausher et al. (1995). Their goal was to closely replicated the original experiments and confirm the existence of the Mozart effect (Steele et al., 1999). Steele et al. choose the 1995 experiment to replicate because there were more procedural details for that experiment than for the earlier ones, and the overall magnitude of the Mozart effect was greater in the later experiment (1999). A total of 125 university students (42 male and 83 female) participated in their experiment. The participants were distributed amongst three groups: 44 listened to the Mozart's Sonata for Two Pianos, K. 448 (Allegro con spirito) for 8 minutes and 24 seconds, 39 listened to a performance by Phillip Glass (Music With Changing Parts) for the same time duration, and 42 students waited an equivalent time period in silence. Immediately after exposure to the listening condition, all subjects were tested on their ability to solve paper-folding and cutting items, the task used in both original experiments. The participants had training with this task in a prior session. This was consistent with the procedure used in the 1995 UCI study. On average, the students answered 10 of 16 items correctly in the training session (mean Mozart = 9.66, Glass = 9.9, Silence = 9.88) and 12 of 16 items correctly in the experimental session (mean Mozart = 11.77, Glass = 12.15, Silence = 11.6). These differences were not statistically different, failing to support the original experiment, despite the meticulous procedural replication (Steele et al., 1999). These finding could indicated that the Mozart effect does not exist, that listening to music prior to a spatial-temporal task does not enhance an individual's ability to complete that task. Due to do the inconsistent finds of the Mozart Effect, Ivanov and Geake further exploration this effect in 2003.

Ivanov and Geake's experiment regarding the Mozart Effect was conducted with fifth and sixth grade students and took place in a more natural setting, the classroom. One of the major differences with Ivanov and Geake's study, compared to Rauscher et al. (1993 and 1995) and Steele et al. (1999), was that the treatment condition was given prior to and during testing, instead of only prior to testing. A total of seventy-six individuals, age ten to twelve, participated in Ivanov and Geake's study. Testing of three treatment conditions took place in the participants' regular classroom, during normal school hours. The treatment conditions were randomly assigned to three classes and were as follows: Prior and concurrent listening to Mozart's Sonata in D major K.448 for two pianos (Philips, 1991), prior and concurrent listening to Bach's Toccata in G major, BWV 916 performed on piano (Sony Classical 1976), and listening to the normal background noise of the classroom/school (control). To test temporal-spatial reasoning ability, Ivanov and Geake used the Paper Folding Test (PFT). No time limit was assigned to the task (Ivanov and Geake, 2003).

Ivanov and Geake found that there was a significant difference in the mean PFT scores between the Mozart group and the control group. Furthermore, a significant difference was found between the Bach group and the control group. Ivanov and Geake dubbed this effect a Bach Effect (2003). This finding is similar to what Nantais and Schellenberg dubbed a Schubert Effect, based on the results of their 1999 study (Ivanov and Geake, 2003). Based on the findings of Ivanov and Geake (2003) and Nantais and Schellenberg (1999), listening to music prior to and during a cognitive task can enhance ones ability to complete that task. These findings may be true, but others argue that listening to background music could be a distraction and a hindrance on the performance of a cognitive task (Ivanov and Geake, 2003).

To explore the distracting effect of listening to music, Filcheck, Allen, Ogren, Darby, Holstein, and Hupp (2004) studied the effectiveness of listening to choice-based music with sixty children, age five to twelve, while undergoing restorative dental work. In this experiment the sixty children were randomly assigned to two groups: the control group or the distraction group. The sample size for each group was thirty. During the dental treatment the control group received no musical stimulus, while the distraction group was able to choose three compact discs from a selection of CDs that ranged from movie sound tracks, children's stories, and top Billboard hits. The participants in the distraction group were given remotes that allowed them to change CDs and tracks at will. The dependent variable that was measured was the level of disruptive behavior of the participant. The results of the study demonstrate that listening to music during restorative dental treatment has no significant effect on disruptive behaviors. Though there was no significance, the level of disruptive behaviors was less for the distraction group when compared with the control group. An explanation for the lack of significance in the data could be that restorative dental treatment is too harsh of a stimulus for music to have a significant distracting effect. That said, Filcheck et al. (2004) begin to demonstrate the positive application of music as a distraction with the decreased level of disruptive behaviors in the distraction group.

Another experiment that explored music as a distracter was conducted by Bourdeaudhuij, Crombez, Deforche, Vinaimont, Debode, and Bouckaert (2002). In their study thirty obese children performed a treadmill test until exhaustion. Two runs were conducted at the beginning and end of the session, one with music and one without, for each participant. During the session where the participants listened to music, they were allowed to choose what they heard. The results that were obtained from this experiment showed that when the children listened to music

and ran on the treadmill they were able to run longer then when they did not listen to music. These results further demonstrated the distracting effects of music.

The results seen from Filcheck et al. (2004) and Bourdeaudhuij et al. (2002) can be explained by the attentional competition theory. In theses studies attentional competition occurs between the internal (the dental work or running on a treadmill) and external (the musical stimulus) cues. Bourdeaudhuij states that bodily sensations are not easy to focus attention towards and do not easily enter ones awareness in the presents of external stimulus. When there is external and internal attentional competition, the focus is given to the external (2002). This results in the perception of less bodily symptoms (Bourdeaudhuij et al., 2002). What occurs if the internal stimulus were replaced with a second external stimulus? Would music have a distracting effect on the other external stimulus? Pool, Van Der Voort, Beentjes, and Koolstra (2000) explored that question using television and homework as the two external stimuli.

In their study, Pool et al (2000) examined the effects of television watching on homework performance. A total of 234 eight-grade students from three secondary schools in the Netherlands participated in two separate experiments. The experimental groups were no television, a Dutch soap opera, and English-language music videos. Five homework assignments were given to each participant, three were expected to be relatively easy for 14-year-olds and two were expected to be difficult for the same age group. The easy homework consisted of: (1) mental arithmetic of 75 addition, subtraction, multiplication, and division problems, (2) a synonyms task consisting of 75 questions, and (3) an antonym task containing 39 questions. The difficult homework consisted of: (1) 15 mathematical word problems and (2) reading comprehension and 17 corresponding questions. The difference between the two experiments was that the second experiment was conducted in the absence of an experimenter and the

participants were either asked to ignore the television and focus on the homework or were allowed to look at the television as desired. The results showed while watching the soap opera, compared to music television or not television, the ability to complete the homework was hindered and that the greater the difficulty of the homework, the greater the hindrance.

Pool's et al. (2000) experiment is relative to the background of this current study because television watching has an audio component similar to listen to music, especially when the program is a music video. While completing homework, most visual attention is directed towards the homework itself, while audio attention is directed towards the television program. This concept allows the use of the theories that explain distraction due to television watching while completing a task to be applied to distraction while listening to music. There are four and the applications of these theories are not mutually exclusive.

The first explanation is based on the limited-attention-capacity theory (Pool et al., 2000). This theory states that we have a limited capacity to process information over multiple tasks. When listening to music while completing a spatial-temporal task, the two draw on the individual's attentional capacity. The total attention required by the two tasks may exceed the person's capacity limit, resulting in a hindrance in the given task. It is argued that this hindrance could be better seen with difficult tasks compared to easy tasks (Pool et al., 2000). This hindrance could be due to the difficult task needing more attentional capacity than the easy task, therefore exceeding the individual's attentional capacity more effectively.

The next theory suggests that the task hindrance is due to structural interference when listening to music and completing the task compete for similar resources of informational processing (Pool et al., 2000). It could be that listening to music and spatial-temporal tasks are parallel tasks. If so, they may interfere with one another.

The next two theories apply to the design of the current experiment. The first of these theories argues that listening to music hinders the ability to complete a cognitive task because salient, attention-demanding elements in the musical piece can draw the attention away from the given task and toward the music (Pool et al., 2000). In this case the primary task (the cognitive task) becomes the secondary task, while the secondary task (listening to music) becomes the primary task.

The second theory states that task hindrance while listening to music could be influenced by an increase in physiological arousal, due to the music. Pool et al. states that learning performance is usually curvilinearly related to an individual's level of arousal (an inverted U function). In this case the optimal level of arousal being greater for easier tasks than for more difficult tasks (2000).

Since the replications of Rauscher et al. (1993) and Rauscher et al. (1995) experiments have resulted in inconsistent findings, the question arises whether a Mozart Effect truly exists. Certainly music has some effect on our mental processes, but to what extent. It has been demonstrated by Ivanov and Geake (2003) and Nantais and Schellenberg (1999) that if the Mozart Effect exists it could be generalize to most classical music. Ivanov and Geake (2003) also demonstrate that listening to classical music during a cognitive task can enhance an individual's ability to complete that task. Filcheck et al. (2004) and Bourdeaudhuij et al. (2002) experiments demonstrate that if music is used as an external stimulus it can distract an individual's internal attention. Pool's et al. (2000) research demonstrated that watching television, which has an audio component, acts as a hindrance, by means of distracting the individual, in the completion of homework. Audio stimulus clearly has some effect on an individual's ability to complete a given task. Whether that effect is enhancing of hindering is

still questionable. If could be argued that listening to classical music could enhance an individual's ability to complete a task. What has not been explored is the effect of listening to non-classical music during a task. Because of this gap in the research, this study was specifically designed to explore the effects of listening to different styles of music while completing a spatial-temporal task, a jigsaw puzzle.

Based on the finding of Filcheck et al. (2004), Bourdeaudhuij et al. (2002), Pool et al. (2000), the inconsistent findings regarding the Mozart Effect, and the concept of distraction, two hypothesize were explored in this study. The primary hypothesis was that while listening to any music, individuals would be distracted and thus take longer to complete a cognitive task. This hypothesis was based on the four theoretical explanations for distraction. If this hypothesis is true, then all the experimental groups will have longer puzzle completion times than the control group, because there is no attentional distraction in the control group. The secondary hypothesis was that while listening to the more aggressive style of music, individuals would be more distracted and thus take longer to complete a given cognitive task than while listening to a soothing style of music, Mozart, or no music. This hypothesis was based specifically on the theory of arousal. I theorize that aggressive styles of music enhance arousal more so than soothing styles of music. If this is true, then the aggressive experimental group ought to have the longest puzzle completion time followed by the Mozart group and the soothing group. The control group ought to have the fastest time due to the complete lack of arousal. The general goal was to draw an individual's attention away from the primary task (the puzzle) by means of a secondary task (listening to music), i.e. distract the individual.

Method

Participants

Sixty-four (41 female, 19 male, and 4 not stated) undergraduate students from Northeastern University, ranging in age from 18-31, with the mean age being 20, participated in this experiment. Each participant was randomly assigned to a group: no music (control), soothing music, Mozart, or aggressive music. Of the sixty-four participants, 62 stated they enjoyed puzzles, 52 stated they listen to music while doing various tasks, and only 13 were familiar with the piece of music they heard. The group was asked to rate their interest in classical and rock music on a scale of 1 to 10 (1 being least and 10 being most interested). The mean scores were classical 5.75 and rock 6.67. The music the group listened to varied greatly. A few examples are: classical, rock, classic rock, metal, rap, punk, indie, reggae, jazz, and alternative. Fifty percent of the subjects received course credit for their participation.

Materials

The puzzle use for this experiment consisted of 24, two inch by two inch, pieces and was chosen for it's moderate difficulty. When completed the puzzle's dimensions were 13 by 10 inches (see Appendix A). The three musical pieces selected contained no vocals. The selections were as follows: soothing music was *Adagio for Strings* performed by the Vancouver Symphony Orchestra, aggressive music was *The Call of Ktulu* performed by Metallica and the San Francisco Orchestra, and Mozart's *Sonata for Two Pianos in D Major, K. 448: I Allegro Con Spirito* performed by Hans Palsson and Amalie Maling was the third experimental group. *Adagio for Strings* was chosen for it's calm and flowing properties; while *The Call of Ktulu* was

chosen for it's fast pace, metal qualities. The Mozart group was added to enable a comparison to the Mozart Effect. The musical stimulus was played from a Compact Presario R3000 using Windows Media Player, through Sennheiser HD 202 headphones. The volume was maintained at identical levels for all experimental groups and not loud enough to cause hearing damage.

Procedure

The experiment was run in the same location on the forth floor of Nightingale Hall for each participant. The room was set up identical for each participant; each participant sat in the same location, as did the experimenter. Upon arrival, each participant was seated at a table and given a consent form, requested to read it, and to ask the experimenter any questions they had. The experimenter then read simple directions to the participant and informed them that this would be a timed process. These directions were typed to ensure that each participant received the same instructions and limit any experimenter bias. The participant was then presented an envelope containing the puzzle and had no knowledge of what the image of the puzzle depicted. The participant then put on headphones, emptied the contents of the envelope onto the table and began the puzzle. The music, and time, was started once the envelope was emptied. The time was stopped when the participant completed the puzzle. Upon completion of the puzzle the participants were given a questionnaire containing seven questions (see Appendix C). A short verbal debriefing followed the completion of the survey. The participants were thanked for their time and reminded that they could contact the experimenter at any time if they had any questions or concerns.

Results

Data was collected on sixty-four participants to address the two hypothesizes. A single factor one-way analysis of variance was used to analyze the data. The resulting analysis demonstrated marginal significants between the control group and the experimental group, P = 0.0644. Fisher's PLSD for puzzle time was then used to analyze where specifically the difference was. The results showed a significant difference between the aggressive and soothing group, P = 0.012, and a marginally significant difference between the Mozart and soothing group, P = 0.0542. The overall results demonstrate that listening to music, in general, has a hindering effect on the ability to complete a given task, in this case a jigsaw puzzle. This finding coincides with the theory that aspects of music will draw ones attention away from the primary task (puzzle) and towards the secondary task (music), thus switching the priority of the tasks. The finding of significant difference between the aggressive and soothing groups is consistent with the arousal theory. The music heard in the aggressive group, and most likely the Mozart piece, created an over-arousal for the level of difficulty of the task. This over-arousal made the given task more difficult to complete, which translated into a longer puzzle completion time.

The arousal theory could also explain the finding that the control group had a longer puzzle completion time, mean = 3.63, than the soothing group, mean = 3.18. It could be theorized that the music heard in the soothing group enabled the precise level of arousal to increase performance on the given task. See Appendix B for group mean completion times.

Discussion

This experiment was designed to test two hypotheses, (1) while listening to any music, individuals would be distracted and thus take longer to complete a cognitive task, and (2) while listening to the more aggressive style of music, individuals would be more distracted and thus take longer to complete a given cognitive task than while listening to a soothing style of music, Mozart, or no music. The results, based on sixty-four participants, demonstrated a strong trend toward significance. This trend suggests that listening to music, while completing a task, does hinder an individuals' ability to complete that task and would support further exploration in this area of study. As for the second hypothesis, analysis of the data lends support to it. This suggests that the type of music heard while completing a task has an effect on an individuals' ability to complete that task. Specifically, for the difficulty level of the given task used, aggressive music had a hindering effect while soothing music had an enhancing effect. Taken together, these data suggests that the choice of music listened to while completing a task may be dependant on the level of difficulty of the given task, i.e. moderate level of difficulty with a higher level of arousal, while easy and hard task are best performed are low levels of arousal. The data may also suggest that not listening to music while doing a task my not be the best idea

The previous statement can be qualified by the finding that the control group had a higher mean completion time that the soothing group. One explanation could be that the soothing style of music was not as capacity dependant as the aggressive style and Mozart group, or that completing a puzzle and listening to the soothing music are not similar mental task and thus do not compete for the same attentional area. A secondary explanation could be that the soothing music increased the physiological arousal of the participants to an optimal level for the given difficulty level of the task used in this experiment. To explore the arousal theory more thoroughly, further research could use one style of music and a similar task of varying levels of

difficulty. This could be conducted using with two simple stress and arousal tests. The tests could be conducted before and after the task. A saliva test could test for levels of stress and blood pressure could test for physiological arousal. This design could be repeated using varying styles of music.

As for the aggressive and Mozart groups having similar completion times, I would not have classified the Mozart piece as soothing even though it is classical. An argument could be made regarding the method used to classify the selected music into soothing and aggressive styles. The classification criteria used was qualitative, not quantitative. What is soothing to one person could be aggressive to another. A better method to use in further research would be to classify music using the tempo of the piece. Slow tempo could be categorized as soothing, while a fast tempo would be aggressive. Unfortunately, I was not able to determine the tempo of the piece used in this experiment, so am unable to make a comparison.

Explanations regarding the increase puzzle completion time of the Mozart and aggressive groups compared to the control and soothing groups are many. It could be these two groups were more stimulating than the soothing/control group and thus required more mental attentional capacity, equaling an increase in puzzle completion time. The music heard in the Mozart and aggressive groups also could have increased the physiological arousal to the point where the arousal distracted the attention from the puzzle. Another explanation for the increase in completion time in these two groups is that the two musical pieces were able to shift the participants' attention from the puzzle to the music. The answer is currently unclear and was not the purpose on this experiment. The experiment was designed to examine if music had an effect on task completion time, not the reason for an effect that, before this experiment was conducted,

was unknown. Further research regarding the findings of this experiment could explore the possible reasons.

In conclusion, the present study showed that listening to music while completing a task effects an individuals' ability at that task. At first glance, the results would suggest that listening to music hinders the completion time of a task. Upon closer examination of the data and applicable theories, it could be plausible that the style of music listened to while completing a given task could enhance the completion of the task. If this is correct, then we could enhance our performance on most any task, if listening to the correct style of music. Further research is needed to qualify this bold statement, but if found to be true many individuals would benefit.

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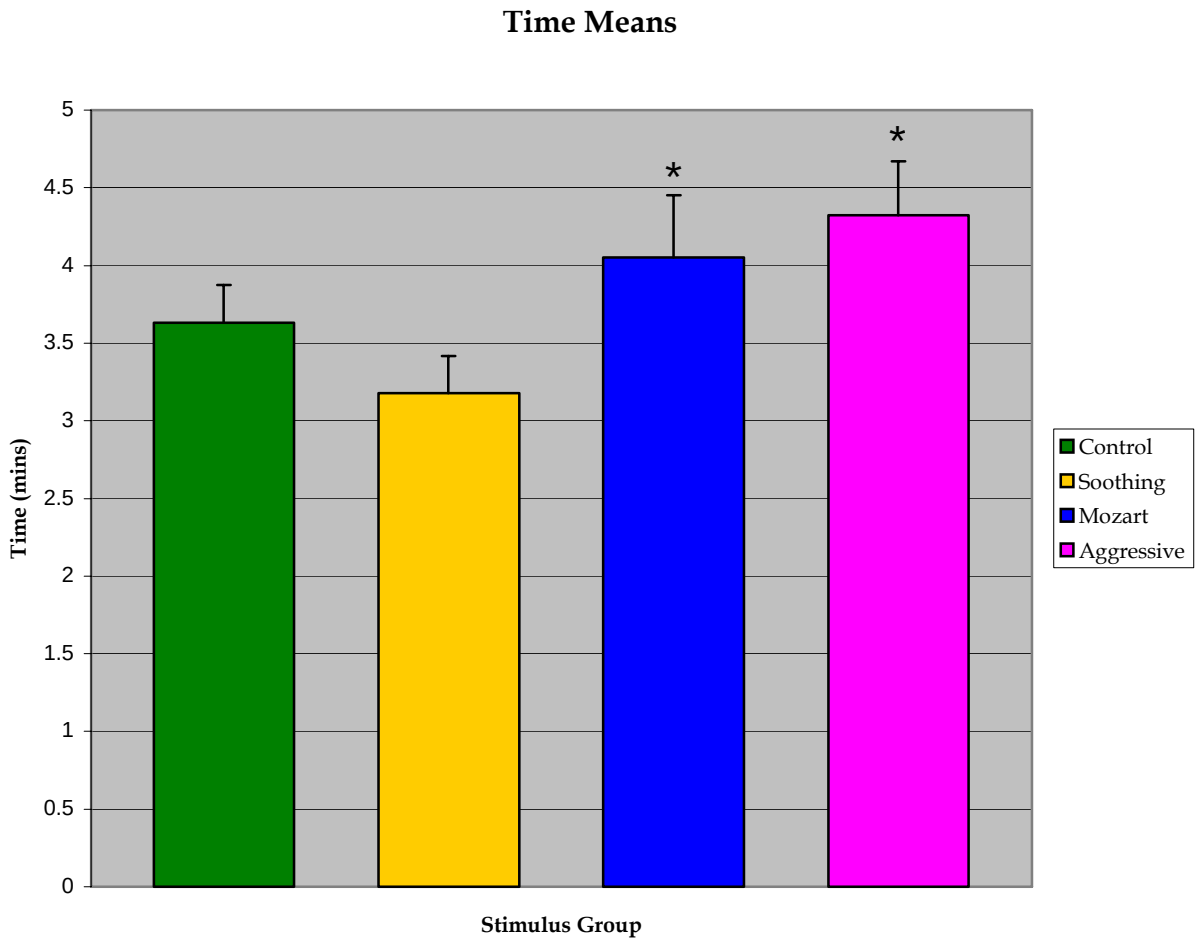
Appendix A

Appendix B



* significant difference compared to soothing group, $p < 0.05$

Appendix C

Age: _____

Sex: Male / Female

Do you enjoy puzzles? Yes / No

Do you listen to music while completing other tasks? Yes / No

If yes, what genre(s) of music do you listen to?

On a scale of 1 to 10 (1 being least interested, 10 begin most interested) what is your overall interest in the following music genres?

Classical

1 2 3 4 5 6 7 8 9 10

Heavy Metal / Rock

1 2 3 4 5 6 7 8 9 10

Were you familiar with the piece of music that you heard? Yes / No

Music Type: _____

Puzzle Time: _____