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Effects of Music Genre on Simple and Simulated Task Switching

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Cover Page Footnote
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Introduction

Hearing or listening to music is a part of everyday life for most people in the twenty-first century, whether it is heard at the store while picking up groceries, in the car while driving to work, or as a backdrop at the gym. Music has made its way into the work environment as well, commonly being heard in hotels, restaurants, retail stores, hospitals, banks, and offices.[1] Some studies suggest that background music improves worker performance, whereas others have shown it to have a negative effect on attention performance.[2] Thanks to contradictory results such as these, researchers have aimed to understand which aspects of music effect attention performance.

Yi-Nuo Shih, Rong-Hwa Huang, and Hsin-Yu Chiang studied the effects of background music with and without lyrics and found that songs with lyrics tended to distract listeners, resulting in a decrease in attention performance, and instrumental music without lyrics did not significantly effect attention performance.[3] In a similar study, Huang and Shih found that the more people either strongly liked or disliked the background music, the more their attention performance was negatively affected.[4] Peter Tze-Ming Chou compared the effects of hip-hop music, light classical music, and no music, finding that music of higher intensity (i.e. hip-hop) is more distracting and has a more substantial negative effect on task performance and concentration.[5]

This study is aimed at better understanding how attention performance on simple and complex tasks is affected by the presence of background music with and without lyrics. One notable model of attention that helps explain previous findings is Daniel Kahneman's limited capacity model.[6] In Kahneman's model, it is theorized that a person

has only a limited amount of attention that can be deployed at any one time. This model has two precepts. First, attention can be distributed freely among different simultaneous tasks and attention is increased or decreased depending on the arousal level of each task. Second, performing multiple tasks requires the amount of attention required by the demand of each single task completed in seclusion, such as little attention being required for easy tasks, while more difficult tasks require more attention. Consequently, one may fail to perform a task because their supply of attention does not meet the demand. As the limited capacity theory has advanced, so have the explanations for attention interference. "One group of theorists argues that interference occurs when the general attentional capacity is exceeded. However, other theorists argue that interference occurs when two tasks compete for the same resources of information processing and the capacity of the specific resource is exceeded a phenomenon called 'structural interference.'"[7] This work focuses on general capacity interference because listening to music can be either a passive or active task, and it can require more or less attention depending on the amount of attention we allocate to listening. Due to the limited amount of attention one can allocate at a time, elements of background media may draw attention away from tasks, thus exceeding one's general attention capacity.

Similar to the current study, Chou analyzed the level of distraction in different types of music on reading comprehension, using Kahneman's model of attention as the theoretical framework.[8] Chou notes that reading comprehension performance is drastically reduced in groups experiencing hip-hop music compared to light classical music or no music at all.[9] Limited capacity theory holds that capacity interference occurs when two simultaneous tasks compete for a person's general capacity of attention, hence

Chou explains his results in terms of the "attention drainage effect," which could be a new type of interference falling under the limited capacity theory.[10] Chou came to these conclusions because participants were told to ignore the background music during the reading comprehension task, and hence claims that the distraction effect occurs not because participants were listening to the music, but because the attention was unconsciously "drained" from the participants.[11]

This rather significant impact music seems to have on attention is quite worthy of research considering the potential consequences on task completion. Task switching and concurrent task completion are commonplace in many work environments of the twenty-first century. Due to the immense pressure to complete as many tasks in the shortest amount of time possible, it is intriguing to further understand the effects music has on these aspects of task completion. Task switching involves focusing attention on the task at hand, and switching attention to another task. Studies concerning this type of multitasking have found that the greatest increase in reaction time to a second stimulus occurs when it is presented (very) quickly after the first stimulus.[12] These deficits brought on by task switching in simple multitasking experiments were found to be the most significant at response-stimulus intervals of less than 0.6s.[13] As previously mentioned, simultaneous task completion can only happen as far as one's attention capacity will allow. Unfortunately, most of the research performed on attention and task switching has been focused on the cognitive mechanisms underlying the process of multitasking, and has yet to have much of a focus on the occupational consequences.[14]

The current research aims to blend these two approaches and tests the following hypotheses: 1) Simple task switching will yield longer reaction times than repeat task

completion and single task completion at intervals less than 0.6s. 2) The group experiencing 'popular' music will yield the highest reaction times whereas the classical music group will yield reaction times similar to the no music (control) group. 3) The participants who perform tasks in a simultaneous (parallel) fashion will complete fewer tasks than those who perform tasks in a serial fashion. 4) Those who experience 'popular' music will complete the least amount of tasks, especially when completing tasks in a simultaneous (parallel) fashion, whereas those experiencing classical music will complete roughly as many as the control group.

Methodology

Participants

The sample of the current study (N=60) was randomly selected from a small Midwestern liberal arts college. Participants consisted of thirty-two females and twenty-eight males ranging in age from nineteen to forty-eight (Mean = 22.78 years of age).

Materials

During the first part of the experiment participants utilized a MacBook Pro laptop and an online task switching experiment suggested by Robert Rogers and Stephen Monsell.[15] A Bose Mini SoundLink Bluetooth speaker played streamed music from an ipad Air at medium volume.

A list of fourteen varying tasks for participants to complete was the main material utilized in the second part of the experiment (see Appendix A). The tasks ranged from reading tasks, to drawing and counting tasks, and were constructed to allow for a total of four dual-task opportunities (such as waiting to hang up the phone, or counting backwards from 30). Utilized materials included ten manila folders with names written

on them, five dry erase markers, five highlighters, seventeen paperclips, nine mechanical pencils, a whiteboard (with two markers), a chalkboard (chalk provided), one light, one lamp, one corded telephone, and printouts of the meeting assignment task, email tasks, and itinerary tasks. The room also had a cabinet labeled "cabinet one" with five drawers inside labeled alphabetically to sort the manila folders into, as well as a drawer labeled "items low on" to place office supplies in. Manila folders, office supplies, and the printouts were all laid out on the table to be used by the participant. Music was played in the same manner as in the first part of the experiment and a seven-minute timer was set on the ipad to ensure consistency in timing

Procedure

In this study, there were two experimental groups and a control group. The type of music being listened to in the background while completing the two-part experiment differentiated these groups. Group one (N=20, the control group) experienced no music, while group two (N=20) experienced classical music (examples of classical songs used include: "Primavera" by Ludovico Einaudi, "Unaccompanied Cello Suite No. 1 in G major" by Yo-Yo Ma, "The Swings of Central Park" by Alexandre Desplat, and "Piano Concerto No. 23 in A major K488 (Candenza by Mozart)" by Mikhail Pletnev. Group three (N=20) experienced popular, upbeat music commonly heard on popular radio stations in the area at the time of this study (examples of popular songs used include: "Happy" by Pharrell Williams, "Keep Your Head Up" by Andy Grammer, "Rude" by MAGIC!, "Moves Like Jagger" by Maroon 5, and "Blurred Lines" by Robin Thicke). Participants were randomly assigned to each group.

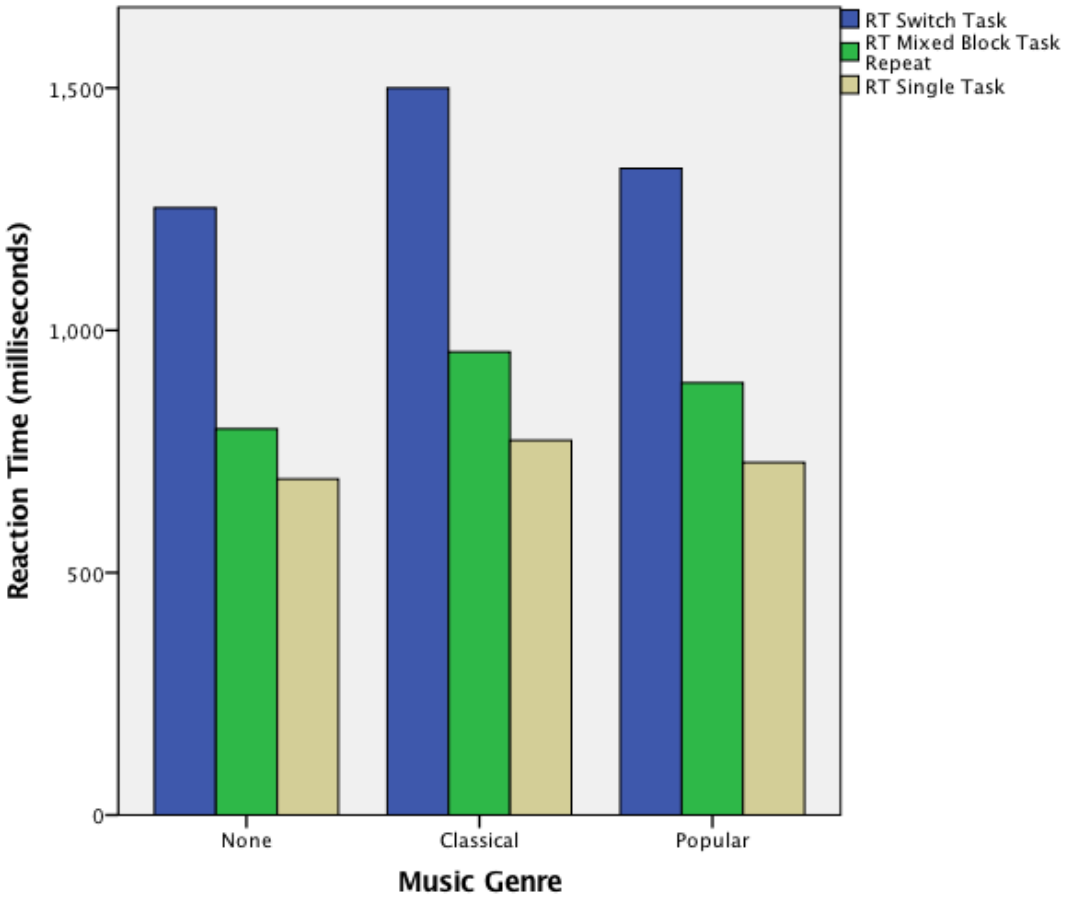
For the first part of the experiment, participants were seated at a table placed in the center of the room with a MacBook Pro laptop computer placed in front of them, and were then asked to complete a computer simulated task switching experiment twice (the first time for practice and the second time to record results). This experiment displayed a square divided into four equal boxes. On each trial a letter-number pair would appear in one box for the participant to respond to. When the letter-number pair appeared on the top two boxes, the participant would respond to the letter pressing "B" when the letter was a consonant and "N" when it was a vowel. When the letter-number pair appeared in the bottom row participants would respond to the number by pressing "B" when the number was odd and "N" when the number was even. This part of the experiment was divided into three segments, the first being AA task design. In this design, the letter-number pair only appeared in the top two boxes with participants responding only to the letter. In the second segment, the BB design, the letter-number pair appeared only in the bottom two boxes with participants responding only to the number. In the third segment, the AABB design, all four boxes were utilized. The letter-number pair would first be presented in the top left box, and moved to the next box clockwise. Thus, during the AA portion, participants responded to the letter in the letter-number pair, and during the BB portion responded to the number. Each segment consisted of twenty presentations of the letter-number pair being presented immediately after a response to the previous stimulus (<.6s), and response times for each trial were recorded and averaged by the program, resulting in the single task reaction time (average of AA and BB segments), mixed block task repeat (AABB design), switch task (AABB design), and switch cost (switch task RT minus task repeat RT).

In the second part of the experiment, participants were given a list of fourteen tasks and were told to complete as many as they could, in any order they would like, before being asked to stop. Participants were allowed to review the tasks before beginning, and were given clarification of the various items found in the room that were to be used with the tasks. Participants had access a pen and told they were allowed to write on any of the sheets made available to them (i.e. tasks list, employee meeting assignment, emails, and itinerary). Once participants indicated they were ready to begin, the examiner told participants to begin and started a seven-minute timer. Data gathered are as follows: Order in which tasks were completed, number of tasks completed, number of times participants chose to dual-task, and whether or not the emails were correctly completed.

Results

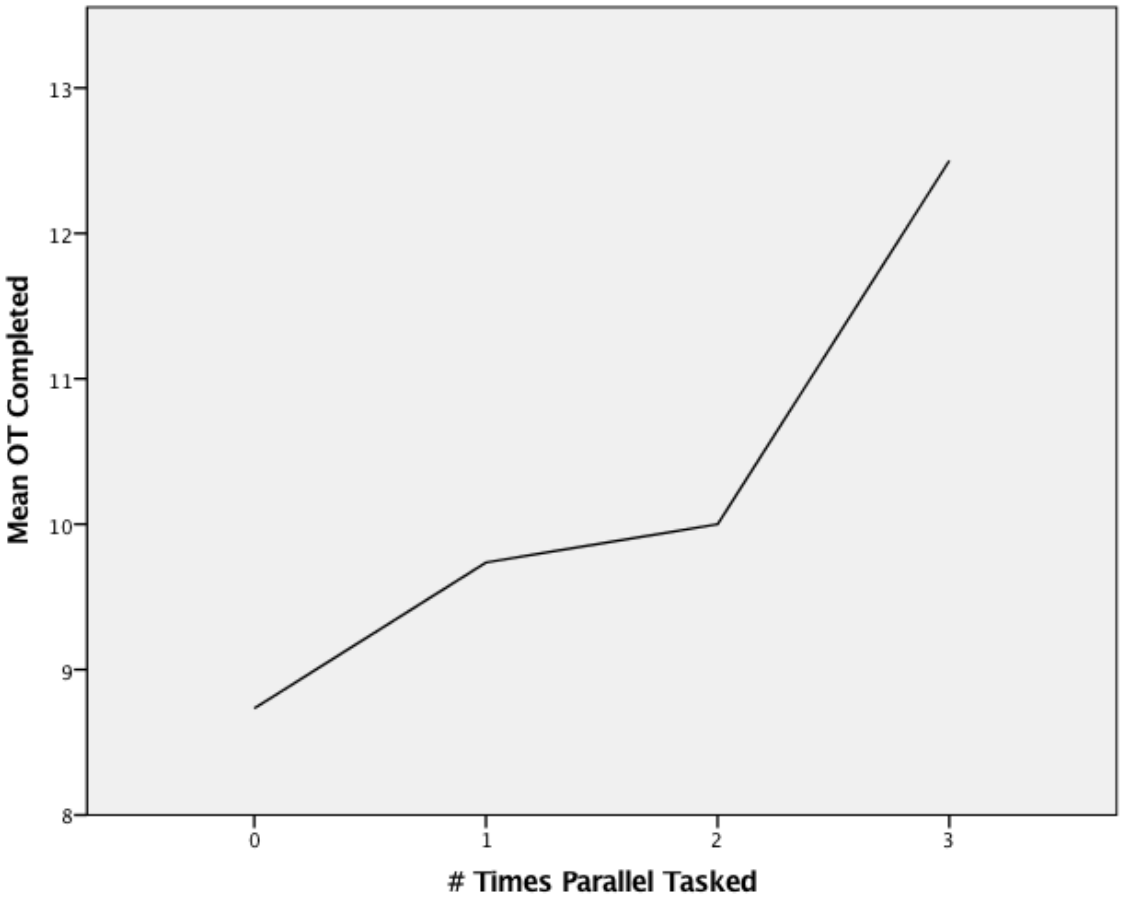
To analyze results from the first part of the experiment, paired samples T-tests were computed for participant's overall reaction times to the single task, mixed block task repeat, and switch task, yielding the following significant results: RT Switch Task x RT Single Task ($T=12.269$, $p<.01$), RT Switch Task x RT Mixed Block Task Repeat ($T=10.504$, $p<.01$,). These results are conclusive with hypothesis one (Figure 1). In comparing these reaction times between music conditions, results were inconclusive for hypothesis two with one exception. For the reaction time in the Mixed Block Task Repeat trial, One-way ANOVA Post Hoc analysis revealed significant mean differences between the classical music condition and the control group: LSD (Mean difference of 158.95ms, $p<.05$).

Figure 1



In regards to hypothesis three, tested in the second part of the experiment, results actually displayed the opposite of the prediction. One-way ANOVA revealed that as people chose to parallel task more, they completed more tasks ($F=4.598$, $p<.01$; Figure 2) Results for hypothesis four were inconclusive.

Figure 2



One-way ANOVA was conducted to see whether or not participants who completed the easy tasks first (i.e. drawing tasks) would be the ones completing the most tasks, ($F=24.277$, $p<.01$), concluding that participants choosing to complete the easy tasks first completed more tasks than those who did not. In assessing whether or not music had an effect on participants correctly completing the email task (i.e.

reading comprehension task), a one-way ANOVA was conducted and Post Hoc tests revealed a mean statistical difference between the classical music group and the control group (Tukey: mean difference=.643, p<.05; LSD: mean difference .643, p<.05; Figure 3). It was also found through a One-way ANOVA that men chose to parallel task more frequently than women (F=4.140, p<.05; Figure 4).

Figure 3

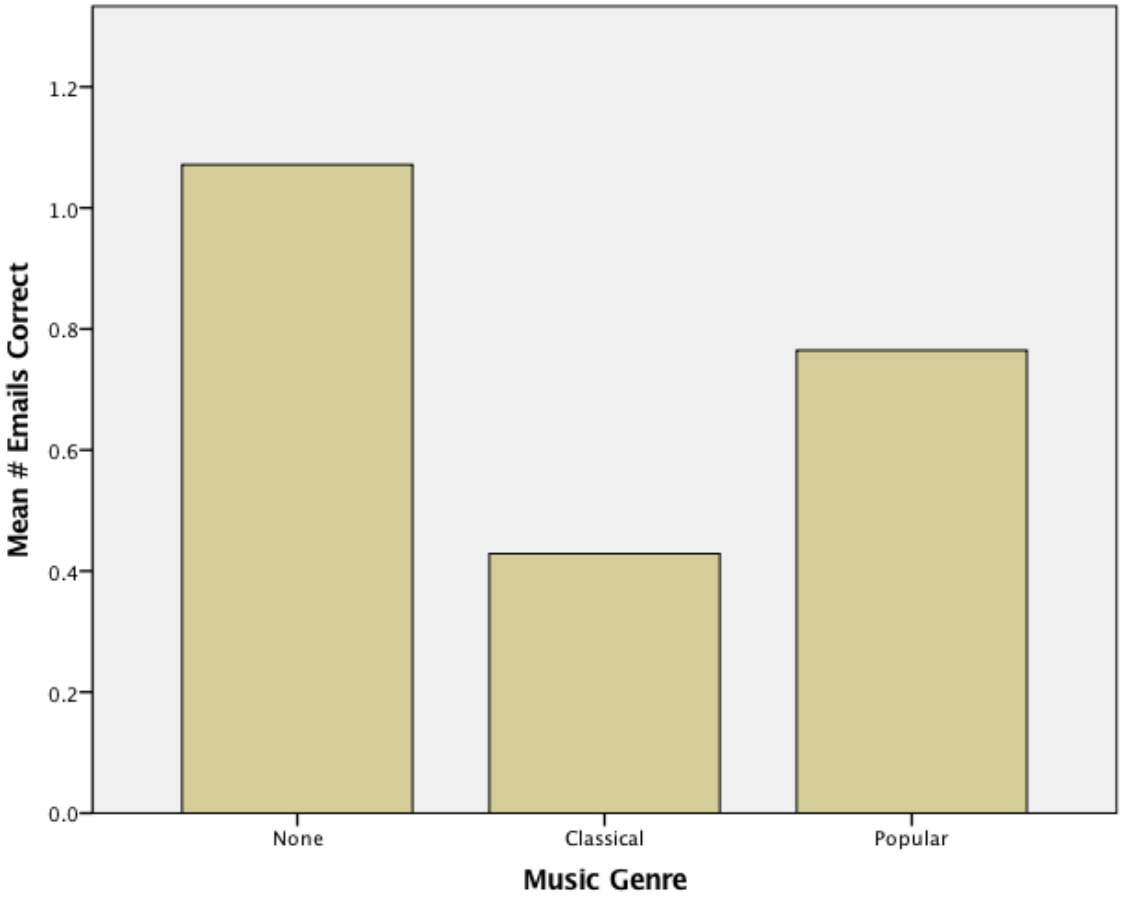
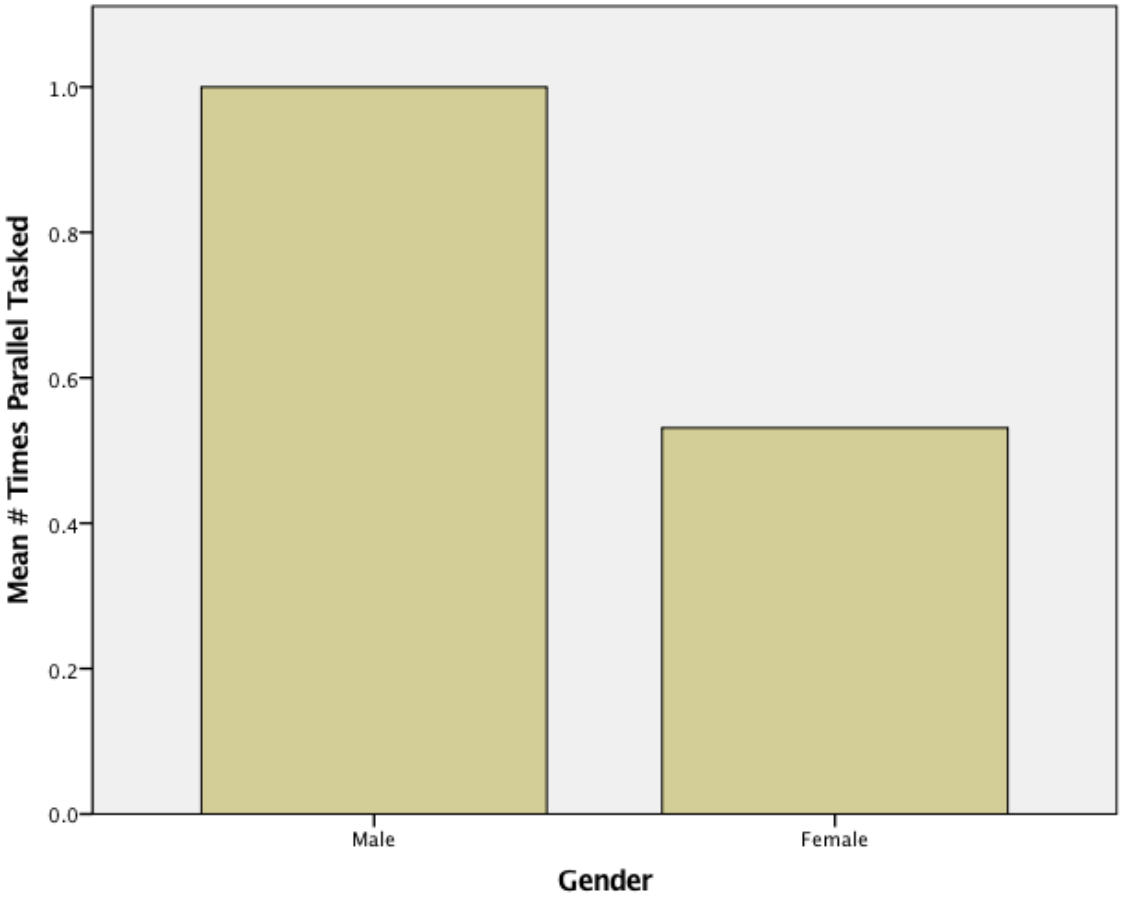


Figure 4



Discussion

Though the data only supports the first hypothesis, results indicate something quite interesting. First, the support of the initial hypothesis is important because it has many implications in real world settings, especially in workplace environments. Due to the numerous demands placed on people to accomplish multiple undertakings as quickly as possible, people tend to 'multitask' by switching between two tasks. For example, an office worker may be writing a budget report while answering emails intermittently. Though the worker may feel as if more is getting done, the costs of continuously switching between tasks actually proves to be more detrimental than helpful, supporting

the findings of Iring Koch, Robert Rogers and Stephen Monsell.[16] As music is also common in the workplace, this research may shed some light on its implications. With the first experiment, though we did not find statistical significance on all measures for hypothesis two, the data do show trends of an increase in reaction time in music groups, especially classical, when compared to the control group (See figure 1). These findings, in part, support the findings of Chou as well as Niklas Ravaja and Kari Kallinen, as background music did show trends of increased reaction time for participants.[17] However, these findings disagree with the findings of Shih and Chou, whose studies indicate that music with lyrics, especially higher intensity music such as hip-hop, should be far more distracting than music without lyrics such as classical music.[18] The current study shows the opposite effect, revealing that classical music without lyrics had a much stronger impact on participants than did popular music with lyrics. In the second part of the experiment, also in opposition of Chou's findings, classical music had the largest impact on responding to the emails correctly when compared to the popular music and control group (Fig. 3).[19] These trends in increased reaction time due to classical music and its inhibition on the email task could be due to multiple factors. Thus, it can be theorized that this is in part due to the attention drainage theory proposed by Chou, however it cannot be fully explained by this because there did not exist such significant results with the popular music group, which would have been expected by the attention drainage theory.[20] One of the reasons classical music may have been more distracting than popular music is participants' familiarity with the music being played. The music selected for the popular music group was selected not only because it is upbeat and contains lyrics, but also because it is music commonly heard at clubs, stores, and on the radio in the local region.

Consequently, these songs are commonly heard by students, and may have been heard enough times to effectively desensitize a subject from the song, leading to less loss of attention to the song, leaving more attention to be allocated by the task at hand. It can be thought that many of the participants who went through this experiment frequently listened to music selected in the popular music group, and not to the music selected for the classical group. For this reason, it is possible that participants may have been distracted by the classical music due to the college age students' lack of exposure to it. Finally, it is also possible that music had less of an effect on participants' rates of task completion simply because many of the tasks can be considered easy, and therefore required less cognitive resources to complete. This finding supports Kahneman's model of attention which claims that performing multiple tasks requires the amount of attention required by the demand of each single task performed in isolation.[21] Since most of the participants (N=45) chose to complete the easier tasks first, the results suggest they completed more despite the music conditions, because their attention resources were not strained enough to slow task completion, even when performing simultaneous tasks. This may be the reason behind the higher task completion rates among those who chose to complete tasks in a parallel fashion. The noted gender difference found is also interesting considering there were no other demographic variables that differentiated males and females. Current research results suggests that music should be allowed in work places that require simple tasks such as stocking shelves, painting, and the like. Since music did seem to inhibit correct email responses and work involving high levels of concentration such as reading and analyzing data, people executing these tasks should avoid the use of music. Future research should explore scenarios in which music conditions are controlled

for familiarity, while incorporating more difficult tasks to seek conditions in which the attention resource threshold inhibits task completion.

ENDNOTES

[1.] Mary Jo Bitner, "Servicescapes: The Impact of Physical Surroundings on Customers and Employees" *Journal Of Marketing* 56, no. 2 (April 1992): 57-71; and Yi-Nuo Shih, Rong-Hwa Huang, and Hsin-Yu Chiang "Correlation between work concentration level and background music: a pilot study" *Work* 34, no. 2 (October 2009): 329-33
[2.] Ibid.; Peter Tze-Ming Chou, "Attention Drainage Effect: How Background Music Effects Concentration in Taiwanese College Students" *Journal Of The Scholarship Of Teaching And Learning* 10, no. 1 (January 1, 2010): 36-46; and Niklas Ravaja and Kari Kallinen, "Emotional effects of startling background music during reading news reports: The moderating influence of dispositional BIS and BAS sensitivities" *Scandinavian Journal Of Psychology* 45, no. 3 (July 2004): 231-8.
[3.] Yi-Nuo Shih, Rong-Hwa Huang, and Hsin-Yu Chiang, "Background music: Effects on attention performance" *Work* 42, no. 4 (August 2012): 573-8.
[4.] Rong-Hwa Huang and Yi-Nuo Shih "Effects of background music on concentration of workers" *Work* 38, no. 4 (May 2011): 383-7.
[5.] Chou.
[6.] Daniel Kahneman, *Attention and Effort*, (Englewood Cliffs, NJ: Prentice Hall, 1973).
[7.] Marina M. Pool, Cees M. Koolstra, and Tom H.A. van der Voort, "The Impact of Background Radio and Television on High School Students' Homework Performance" *Journal Of Communication* 53, no. 1 (March 2003): 75; and Patrick A. Bourke, John Duncan, and Ian Nimmo-Smith, "A General Factor Involved in Dual task Performance Decrement" *Quarterly Journal Of Experimental Psychology: Section A* 49, no. 3 (August 1996): 525-45.
[8.] Chou; and Kahneman.
[9.] Chou.
[10.] Chou; and Kahneman.
[11.] Chou.
[12.] Iring Koch, "Mechanismen der Interferenz in Doppelaufgaben" *Psychologische Rundschau* 59, no. 1 (2008): 24-32.
[13.] Robert D. Rogers and Stephen Monsell, "Costs of a predictable switch between simple cognitive tasks" *Journal Of Experimental Psychology: General* 124, no. 2 (June 1995): 207-31.
[14.] Hiltraut M. Paridon and Marlen Kaufmann, "Multitasking in work-related situations and its relevance for occupational health and safety: Effects on performance, subjective strain and physiological parameters" *Europe's Journal Of Psychology* (November 2010): 110-24.
[15.] Robert Rogers and Stephen Monsell are experimental psychologists from the University of Cambridge whose research article, “Costs of a Predictable Switch between

Simple Cognitive Tasks," inspired the first portion of the experiment. They aided in this experiment by providing the link to the online task switching experiment.
16. Koch; and Rogers & Monsell.
17. Chou; and Ravaja & Kallinen.
18. Yi-Nuo, Huang, and Chiang, "Background music: Effects on attention performance"; Chou.
19. Ibid.
20. Ibid.
21. Kahneman.

Appendix A: The Fourteen Tasks Participants Completed

Turn on the lamp on the blue table **AND** the light between the cabinets

Alphabetize by last name the 10 manila folders on the table. Then store them in the appropriate drawers found in "cabinet 1"

Assign each employee a meeting time (Employees listed on sheet) (Appendix B)

Sort and count the office supplies found on the table

For each item we have less than seven (7) of, place them in the drawer labeled "Items Low On"

Read Email number one and count the number of times "that" appears (Appendix C)

Make up and tell me a story about a dog

Read Email number two and count the number of spelling errors (Appendix C)

Create an itinerary for a business trip. Choose one flight, one car rental, one hotel reservation and two activities. (Appendix D)

With your left hand, draw four (4) circles on the **whiteboard**

Pick up the phone when it rings, wait approximately two minutes, and hang it up

Count backwards from 30 for me

With your right hand, draw four (4) squares on the **whiteboard**

Draw a cat on the **chalkboard**

Appendix B: Employee assignment task

Employees: John Watkins, Roger Wallace, Bill Jones, John Melon, Hue Jazz, Camile Johnson, Dan Baker, Kelsie Miller, David Bacon, Paul Bean.

Instructions: Each employee is required annually to a private meeting. Schedule each employee in one of the following time slots:

9:00 AM May 3rd. - _____

3:00 PM May 6th. - _____

11:30 AM May 8th -_____

7:00 AM May 12th -_____

2:00 PM May 14th-_____

8:30 AM May 16th-_____

9:45 AM May 18th-_____

10:15 AM May 19th-_____

11:30 AM May 20th-_____

9:15 AM May 22nd-_____

Appendix C: Email editing (reading comprehension) task

Email Number One (1).

Hello Governor,

That is quite the bright little teakettle you have sitting on that wonderfully colorful countertop. I have always quite fancied that specific teakettle, as it is the best in your collection. Not to be rude, but I inquire as to the next time that I visit your quaint little shack in the abbey; you might allow me to touch the kettle. Oh the joy that would give me. I know you are constantly busy working on research projects and the like, as well as I know how much of a droll it is for you to be so overwhelmed with your work. Please receive my heartfelt compliments of that fine teakettle; you have something to be proud of!

Much obliged,
Sir William Wallace

Number of times "that" appears:

Email Number Two (2).

Dear Janice,

It has come to my most noetable attentoin that we are in nead of a business trip. I was thinking we could go to Rome or Spain and raelly get away from all of this hectic work. Because we typeically have very busy schedules, I imagine that it would be best for us to plan a trip over this summer. Is there any way that you would be able to put together an iteneray for this trip, maybe something that would give us a better idea of a plan we could make? It would be much apprieciated.

Thanks,
Boss Man.

Appendix D: Itinerary task

Make an itinerary for a business trip. Pick one flight, one car rental, one hotel rental, and two activities to take part in.

Airline Flights

American Airlines Flight 342 to Rome – Round Trip
Departure from Wichita Mid-Continent Airport at 8AM, August 15th, 2015
Land in Atlanta Georgia at 10:15AM
Depart Atlanta at 12:00PM
Arrive in Rom at 6:00PM, August 16th, 2015
Return Flight
American Airlines Flight 983 to Wichita, Kansas
Departure from Rome at 7:00PM, August 21st, 2015
Land in Atlanta Georgia at 2:00AM August 22nd, 2015
Depart from Atlanta at 5:00AM
Arrive in Wichita at 7:00AM August 22nd, 2015

Delta Airlines Flight 573 to Rome – Round Trip
Departure from Wichita Mid-Continent Airport at 5:30PM, August 18th, 2015
Land in Chicago Illinois at 7:00PM
Depart Chicago at 10:00PM
Arrive in Rome at 11:00AM, August 19th, 2015
Return Flight
Delta Airlines Flight 673 to Wichita Kansas
Departure from Rome at 4:00PM, August 26th, 2015
Land in Chicago Illinois at 12:00PM August 27th, 2015
Depart from Chicago at 3:00AM
Arrive in Wichita at 5:00AM August 27th, 2015

Car Rentals

2013 Toyota Camry – 25/29 mpg, city/highway. - $75 per day

2015 GMC Terrain – 22/26 mpg, city/highway. - $110 per day

2011 Hyundai Tucson – 24/27 mpg, city/highway. - $87 per day

(Appendix D continued)

Hotel Reservations

Hyatt Regency, Frascati, Italy. $125 per night, per room. (45 minutes from destination)

Double Tree Hotel, Marino, Italy. $150 per night, per room. (30 minutes from destination)

Hilton Suites, Rome Italy. $200 per night, per room. (10 minutes from destination.)

Activities to take part in during the week

Leaning Tower of Pisa

Frascati Vineyards

Visit the Coliseum

Visit Vatican City

Itinerary: