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Does Music Percussion Has Impact on the Selective Attention of College Students?

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by

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Abstract

Objective: Previous studies indicate that fast or high-pitched music has a negative effect on people's attention. However, some kinds of music could improve study efficiency. This study compared how pulse and sound frequency affect the selective attention of college students.

Participants: Forty-two Bard College students, aged from 18-24, participated in this study.

Method: Four groups of participants listened to background music that shared the same melody line but differed on the dimensions of pulse (every half notes vs. Every quarter notes) and frequency (about 580Hz vs. 43Hz) as they completed the d2 test of selective attention. The effect of music on selective attention was analyzed.

Results: Due to the small sample size, there was not a statistically significant result.

Conclusion: Base on the fact that there was not result, future study need to be pursued.

Keywords: attention, selective attention, music, music therapy, pulse, audio frequency

Attention, also known as focus, refers to a behavioral and cognitive process that selectively concentration on a discrete aspect of information, while ignoring other perceptible information. It plays an essential part in studying and working (among other tasks); therefore, people around the world have regularly sought ways to stay focused. Back in the *Warring States Period* in China(475–221 bce), a scholar named Su Qin was noted for using an awl to stab his own thighs to keep him awake and focus when he tried to study at late night*. Nowadays, many people around the globe attempt to sustain their attention by consuming caffeine. Indeed, the sales of products containing caffeine continues to increase and results in an increase in emergency room visits and calls to poison control centers (Mcilvain et al., 2011). Obviously, these two methods (stabbing oneself and developing an unhealthy reliance on caffeine) may not be good choices since they is very harmful to our health. However, people still need an effective way to pay attention in order to improve their productivity so that they could be more efficient in working or studying. Since attention is a concept that is studies in the field of psychology, therefore, there are some psychological treatments or interventions to improve people's ability of sustaining attention, for example, focused meditation has been proven to be an effective way to regulate attention (Menezes, C. B.,et al, 2013). However, that intervention is a long-term method that need people to practice to have effect, yet for college students that are

*The story was in a ancient Chinese history book called *Intrigues of the Warring States*, the author and the year of the book is unknown.

preparing for exams, they would prefer an effective intervention during studying so that they would not spend extra time.

When it comes to psychological treatments or interventions with fewer side-effects, a great example would be music therapy. Music therapy is based on the theories and methods of psychotherapy, and it makes use of the unique psychological effects of music, such as attention modulation and emotion modulation, to enable patients to experience music through various specially designed music behaviors, such as vibroacoustic therapy(Alvin & Andrews, 1975). Since this treatment does not involve any medication, there are few side-effects. Also, music therapy has been shown to be useful to help with attention. A previous study was investigating whether listening to pleasant music could improve visual attention in patients with unilateral neglect after stroke, and the result showed that compared with unpleasant music(including heavy metal, rap, rock and military songs) and white noise, participants rated their moods as more positive and arousal as higher with pleasant music(well-known Taiwanese songs from famous Taiwanese singers). However, the participants in this study were patients with unilateral neglect, which is an attention disorder that arises as a result of injury to the cerebral cortex resulting in lack of awareness of one side of their body (Chen et al., 2013). As such, the results may not generalize to the neurotypical college students. What college students need are interventions to stay focus during intense study, rather than treatments for patients who are physically unable to stay in focus. Also, due to the diversity in the aspect of demography and music tastes at Bard College, the intervention of “pleasant music”

might not be suitable for Bardians since we have different definition of “pleasant music”. Therefore, I decided to investigate whether a simple musical intervention can benefit college students, so that I could help students in Bard College to find out the suitable kind of music for students to listen to while studying.

I have decided to study specifically about the percussion in music, which refers to sounds produced by striking with the hand or with a handheld and pedal-operated stick or beater, and by shaking, including drums, cymbals, and bells. Like salt to a dish, percussion is a very essential factor to music (Duckles,1955). It takes in charge of the pulse and rhythm of the music; also, it has varieties of tone, which is determined by the range of sound frequency. From all those components, I chose to study pulse and range of sound frequency in percussion.

On one hand, pulse is a steady beat like a ticking clock or your heartbeat; in other words, pulse is the times that percussion occurs in a measure. The reason why I chose pulse is that changing pulse does not affect the overall tempo of the music; therefore, the melody line will stay the same despite the changing pulse, so that the experimenter could have better control of the independent variables of percussion and avoid the occurrence of the third variables. On the other hand, range of sound frequency is measured by Hertz (Hz), and it refers to the total number of waves produced in one second , or in the other word, the pitch of the sound. The audible frequency, which is the sound frequency that normal human could hear (Pilhofer et al., 2019), ranges from 20 to 20k Hz (Rosen & Howell, 2011). Sounds in the high frequency range (5000-20000 Hertz), such as screaming, might keep people awake

but are also frightening (and therefore distracting); sounds in low frequency range (20-300 Hertz), such as the bass part of a Gregorian chant, might keep people calm but risk putting them to sleep. Sound in extreme high or low range would be harmful to human body. Exposure in high ranged sound frequency (13.5k to 20 kHz) would lead to the result that the participants feeling uncomfortable, annoyed and difficult to concentrate (Fletcher et al., 2018). Also, exposure in low-frequency noise over 3 mins seems to produce obvious symptoms, including breathing disorders and auditory pain (Berglund et al., 1996). Since these extremes would not only not be beneficial for attention—and might also do harm to people—I decide to use sounds in more moderate and less harmful range and discover if there is any interaction with pulse.

Selective attention refers to a process that allows individuals to select and focus on specific inputs for further processing, while inhibiting irrelevant or distracting information. The reason why I chose to study specifically about selective attention is that selective attention plays an essential role in whether we can easily stay focus during studying (Stevens & Bavelier, 2012).

I was unable to find any existing empirical literature concerning the impact of music pulse or range of sound frequency on attention; however, there are some studies about the relationship between related elements.

On one hand, pitch does have an observable effect on memory. As mentioned before, pitch depends on the range of sound frequency. The higher the range of sound frequency is, the higher the pitch. Also, memory requires the participation of selective attention since attention filters the incoming information and only allows the relevant

information to enter the short-term processing storage (Downing, 2000). There was a study result showed that low pitch music could facilitate long-term memory. That study was in a 2x2 mixed-subject design, and the participants was listening to either a high or low pitch music while completing two word span tasks of differing word frequency (high and low) sequentially. A a marginally significant main effect of music pitch was found with an insignificant interaction, which the increased pitch on music would lead to the decreasing of memory.(Koh et al., 2014). Therefore, it could be inferred that how range of sound frequency could influence people's selective attention.

On the other hand, the tempo of music has an impact on people's reading comprehension, which is measured by the correct rate of reading comprehension tests. It has been indicated that faster music is more disruptive to reading. In a study with a 2x2 design, where the independent variables are tempo(fast vs. slow) and intensity(high vs. low), 25 participants were given 4 minutes to read an article and then 3 minutes to answer 6 multiple-choice questions in each condition. Baseline performance was established by having control participants complete a reading task quietly. A significant rhythm of strength interactions was observed, with understanding under fast/high conditions significantly lower than baseline. These findings suggest that listening to background instrumental music is most likely to disrupt reading comprehension when the music is fast and loud.(Thompson et al., 2012). Tempo and pulse are both the timing factors of percussion. Also, there is a relationship between reading efficiency and selective attention (Casco et al., 1998).

Therefore, we could infer there might be some impact that music pulse would have on selective attention.

Hypothesis

Based on the aforementioned literature, I predicted that there would be a main effect of music pulse on attention, in that increased intensity of pulse would lead to the decreasing of attention. Furthermore, I predicted that there would also be a main effect of audio frequency on attention, in that increased range of frequency would result in the decreasing of attention. Simply based on those two hypotheses, the combined effect of a moderate pulse and low pitch could be ideal; however, based on my personally experience, music fitting this description, such as most of the Gregorian chant, does not help me to stay focused. To the contrary, it makes me feel sleepy. Therefore, I predicted an interaction between pulse and frequency range, such that when frequency range decreases and the intensity of pulse decrease, attention would decrease.

Method

Participants

Due to the reference of previous of study on similar topic (Chen, 2013; Koh, 2014), which the sample size ranged from 54-102, and the practicability, I originally planned to have a sample size of 60 students recruited from Bard College. However, due to the time limitation, the final sample size is 42, which all participants are (1) at least 18 years of age; (2) currently studying at Bard College; (3) free from a diagnosed hearing (e.g., hearing loss or tinnitus) or attentional impairments (e.g., attentional deficit/hyperactivity disorder or ADHD); free from any visual impairment that is not corrected by glasses or contact lenses; (4) willing to participant.

All of the participants were recruited by digital posters that I posted on social media (Instagram, GroupMe, and WeChat) and physical posters that I spread around campus.

Design

The experiment was done in person, and it was a between-subject 2x2 study. A fully between-subject design was chosen to avoid potential carry-over effects/switch costs as any given participant transitioned from listening to one type of music to another.

The participants were assigned to one of four groups. Group 1 with intense pulse in high frequency range; Group 2 with intense pulse in low frequency range; Group 3

with moderate pulse in high frequency range; and Group 4 with moderate pulse in low frequency range(Table 1).

Table 1

Group Assignment

	High range of sound frequency (about 580Hz)	Low range of sound frequency (about 43Hz)
Intense pulse (every quarter note, four times a measure)	Group 1	Group 2
Moderate pulse (every half note, twice a measure)	Group 3	Group 4

Music

The music that is provided to the participants is a rearranged version of a song that I wrote about a year ago in my electroacoustic composing class. I took out all the vocal parts in this piece, and replaced the sounds of musical synthesizers with piano and string instruments. The music is in five-part rondo form (ABABA' structure). The key of this song is in a minor, and the reason why I chose this key is that a minor is the only natural minor that does not include any black piano keys in the key, which might sound sorrowful (Hevner, 1935). Using a minor as the key of the piece of music instead of other minor keys could make the music sounds more peaceful than sad; otherwise, a sad piece of music could distract people's attention. The tempo of this music is *Andante* (80 BPM), which is a walking pace, moderate tempo, and the meter of the music is 4/4, which is the most common meter in the musical world. The

production of this music was done by the musical software FL studio, and did not including any recorded sounds.

The melody lines (including pitch and speed) are completely identical across all four groups. The only difference was in the percussion parts or the beat.(Table 1)

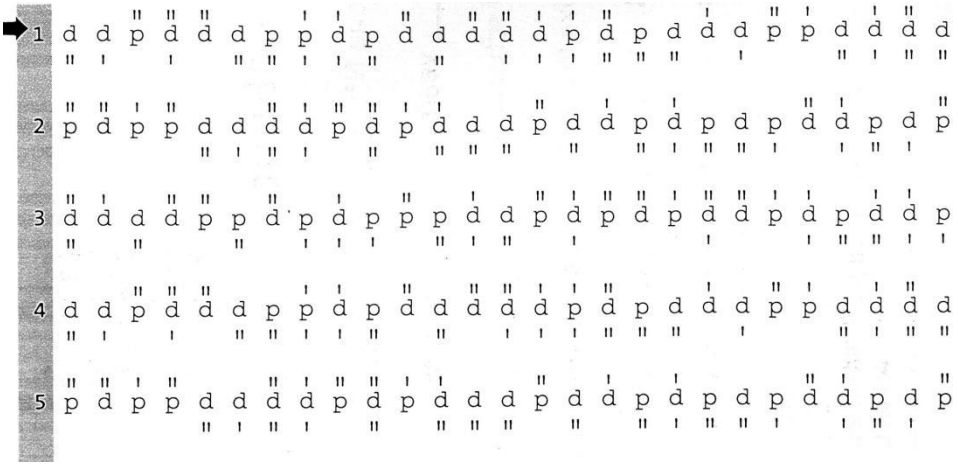
In the study, the music will be play through a headphone in a comfortable level of volume.

d2 Test of Attention

The tool to measure one's attention that was used in this experiment was the D2 attention test, which is a one-page paper-and-pencil test for selective attention. The standard version of the d2 consists of 14 rows (trials), each with 47 randomly mixed "p" and "d" letters, for a total of 658 letters. The target symbol is a "d" with two dashes (hence "d2"). The participant's task is to cancel out as many target symbols as possible, moving from left to right (Figure 1), with a time limit of 20 s/trial (Lee et al., 2018; Brickenkamp & Zillmer, 1998). This test of selective attention is suitable for this experiment since the rules are easy to explain and understand, also, this test does not require any skills and pre-requirements, such as math or languages. This test have been applied with various of population to test their attention ability, however, there is no average score of college student on this test that I have yet found.

Figure 1

Example of Paper-Pencil d2 Test



Note. the image is from Yato et al.

The variable selective attention was measured by the test score of the d2 test, which including the total number of characters canceled (TN, total number—an index of processing speed), errors of commission (C, non-target characters canceled), errors of omission (O, target characters respondents failed to cancel), total errors (TE, sum of the errors of commission and errors of omission), the number of characters correctly canceled minus the number of errors of commission (CP), and the number of characters correctly canceled minus the sum of the errors (TN-TE; Brickenkamp & Zillmer, 1998). It was diThese scores are separately calculated for each of the 14 lines of the test,

Pilot Study

Participants were tested individually in the Red Room of campus center. After

signing the consent form, the experimenter would tell them to choose a number from 1 to 4 to decide which group they will be in, without letting them know which number refers to which combination of musical percussion. The reason why I did not assign groups for them by myself is that I knew most of the participants, and I could avoid manipulating data by not intervene the group distribution since I might know some of their study efficiency. Next, the experimenter would show a sample of a completed d2 test to the participants, explain the rules of this test, and make sure the participants know what to do. The participants were told that they had 4 minutes and 54 seconds to complete all 14 trails, and the average time limit for each trails was about 20 seconds. The participants were listening to music of the group they chose previously while completing the test. Since the test was printed double-sided and there are 7 trials on each side of the paper, the participants were told that the experimenter will notice the participants by knocking at the table when the song is played to the middle point to remind the participants it is the time that they supposed to finish the trails on the first side of the paper, so that they could adjust the speed of completing test to make sure they could finish it right on time.

After completing the test, the participants were given the debriefing form and have their email address recorded for the lottery drawing.

Limitation of Pilot Study

The data of all 7 participants that was collected in the pilot study was excluded from since I found out the procedure was unreasonable and would decrease the

validity of the result. However, I still did some basic descriptive analysis of the data for reference.

First of all, in the standard d2 test of attention, the time limit of each trial is exactly 20 seconds, instead of 20 on average, and that changed results in the fact that four of the participants in the pilot test could not finish the test, and most of them left at least 2 trials blank. The participants told me that the setting of time limitation was unreasonable since even if they knew they supposed to spend 20 second in average for a trail, but without the notice of time, they were not aware of the time and could not arrange the time in each trail well. Therefore, in the following experiment, Ifind a way to make sure the time spend in completing each trail is accurately 20 seconds.

Additionally, some of the participants' time completing the test was wasted when flipping the paper. The paper was printed in both sides, and I did not notice the participants that the paper should be flipped in the long edge. Also, the letters on the test contains only "d" and "p", therefore, even though the paper is upside down, it takes the participants some time to notice it, and after they noticed that mistake, they have to spend extra time on correct those "p" that was falsely crossed out, and see if there is any missing "d2." Thus, the participants should be informed which way to flip the paper.

Last but not least, when choosing the group number, the participants tended to choose number 3 (three participants) or 4 (two participants), leading to unequal cell sizes, especially for Group 1 and 2 (only one participant in each group)[*]. This mistake was corrected in the main experiment, for which group assignment would be

randomized and result in more equal cell counts.

Main Experiment

All participants were tested individually in the Red Room in campus center. Upon arrival to the testing location, participants would tell the experimenter their email address for the lottery drawing. After that, the participants were given the informed consent sheet to examine. I would emphasize that, to be eligible, participants should not have any visual, attention, or hearing conditions that might make their participation frustrating or irritating (e.g., tinnitus). Furthermore, I would underscore their ability to withdraw from the study at any point without penalty. Once they had chance to have any questions they might have about the experiment answered, I would ask them to sign the consent form if they indicate that they are eligible and agree to participate.

Next, for group assignment, I numbered the test paper evenly into every group every experiment day after collecting the number of the participants to make sure there would not be a big sample size difference among groups. When the participants arrived, I just pick a numbered test paper randomly without looking at the labeled number for them. In that way, I could make sure the group assignment were both random and even.

After that, I introduced the d2 test of attention to the participants, including showing them the sample test, telling them there are 14 trials and each includes 47 random letters, and the time limit for each trail is 20 second. Different from the pilot

test, I emphasized that paper should be flipped on the long edge so that they won't waste time on that step.

Following up, I showed them the time reminder. The audio clips they will be listening to while completing the test were made into videos with a completely black background. The screen that displayed the video was right next to the test paper so that the participants was able to notice the change of the screen easily. Every 20 seconds, the color of the background of the picture would turn white for 0.5 second to inform the participants that it is the time to do the next trial. I told the participants to make sure the time they spend on each trail should be exactly 20 seconds, for example, if the screen turns white when the participants did not finish trail 1, the participants should still start to do trail 2 immediately and ignore the unfinished trail 1; also, if the time spent on trail 1 is less than 20 seconds, the participants could not start doing trail 2 until the screen turns white.

After making sure that the participants completely understood the procedure, I gave the participants a pair of headphones with disposal covers (changed for every participant for sanity) and told them to adjust the headphone and try the pen that I provided to see if it's writing fine. After the participants told me they were ready, I handed them the test paper and start the test by playing the music right after.

After the participants finished the test, they were given debriefing forms and were asked if they had any questions.

The time of the d2 test itself was 4 minutes and 50 seconds, with each participant taking about 13 minutes on average to complete informed consent, receive the

instructions, take the test itself, and go through debriefing.

Data Analysis

All data were analyzed by using Jamovi (Version 1.1.9.0). I ran a 2x2 ANOVA for each of my dependent measures: O (omissions—the number of target items that were ignored across all trials) and E (the total number of errors, omissions+commissions). The two between-subject independents variables are the Pulse (Intense vs. Moderate) and Frequency (High range of sound frequency vs. Low range of sound frequency). I set the alpha (significance) level at 0.05.

Results

Pilot Study

Due to the small sample size (seven participants, including one in Group 1, one in Group 2, three on Group 3, and 2 on Group 4) and the problematic procedure, the data were too compromised to use to draw firm conclusions. However, to guide the revised version of my procedure, I still report a few features from the descriptive statistics. No inferential statistics were run on the data from the pilot study, however.

Notably, there were three participants in the pilot who did not complete the test; in the other words, they have left at least one trail blank. Surprising, all three of these participants were in Group 3, which is the combination of moderate pulse and high range of sound frequency. However, in those parts that they had finished, there were numerically fewer omissions compares to other groups. That might indicate that for music with percussion, moderate pulse and high pitch could be suitable to listen to while taking tasks that have no strict time limit and require perfection.

Secondly, all of the commission errors were limited to Groups 1 and 2, which are the two groups with intense pulse. There was only one participant in each group (two commission errors from the participant in Group 1 and three commissions from the participant in Group 2), even though the sample size was too small to draw any conclusions from these results, it is notable that commission errors were only found in conditions involving an intense pulse. At least based on these limited data, intense musical pulse did not seem to help these pilot participants distinguish interference

items from target items.

Main Experiment

Commission Errors

Commission errors were infrequent in the main data set. Among all of the 42 participants, only seven made mistakes of commissions, including one that had two commission errors. The rest had a single commission error each (Table 2). However, in Group 4, which is the group with moderate pulse and low range of sound frequency, there were no commission errors made, implying that listening to this type of music might be suitable for tasks that penalize false alarms (i.e., detecting a target when no target is present).

Table 2

Comparisons Commission Errors by Group

	Group 1	Group 2	Group 3	Group 4
n	11	10	11	10
Mean	0.182	0.300	0.182	0.000
Median	0	0	0	0
Minimum	0	0	0	0
Maximum	1	2	1	0

However, due to the small number of observations per cell and the huge difference between the data in the previous studies ,in which the commission errors range from 5-10(Lee, 2018), conditions were not met to run an inferential test on the commission errors, such as the chi square test of independence. However, all of my hypothesis was simply on the overall performance on selective attention, and did not have any strong predication specifically on either commission or omission errors. Thus, any firm conclusions on this measure require further research.

Omission Errors

Unlike errors of commission, omission errors were frequently in my dataset (Table 3).

Table 3

Comparisons Omission Errors by Group

	Group 1	Group 2	Group 3	Group 4
N	11	10	11	10
Mean	32.5	29.8	32.8	31.7
Median	30	28.5	34	32.5
Minimum	19	11	14	7
Maximum	54	52	53	68

From Table 3, we could see that the music in Group 2 might be the best

combination to help people stay focused; on the other hand, music in Group 1 and Group 3 might be distracting attention. Both Group 1 and Group 3 consist of high sound frequency, which is consistent with my prediction of the main effect that when pitch increases, attention will decrease. However, we still need to run tests with the data to support our hypothesis.

Total Errors

Due to the lack of data in commission errors, the data of total errors is very similar to the data of omission errors (Table 4).

Table 4

Comparisons Commission Errors by Group

	Group 1	Group 2	Group 3	Group 4
N	11	10	11	10
Mean	32.6	30.1	33.0	31.7
Median	30	29	34	32.5
Minimum	20	11	15	7
Maximum	54	52	53	68

Main Effect & Interaction Effect

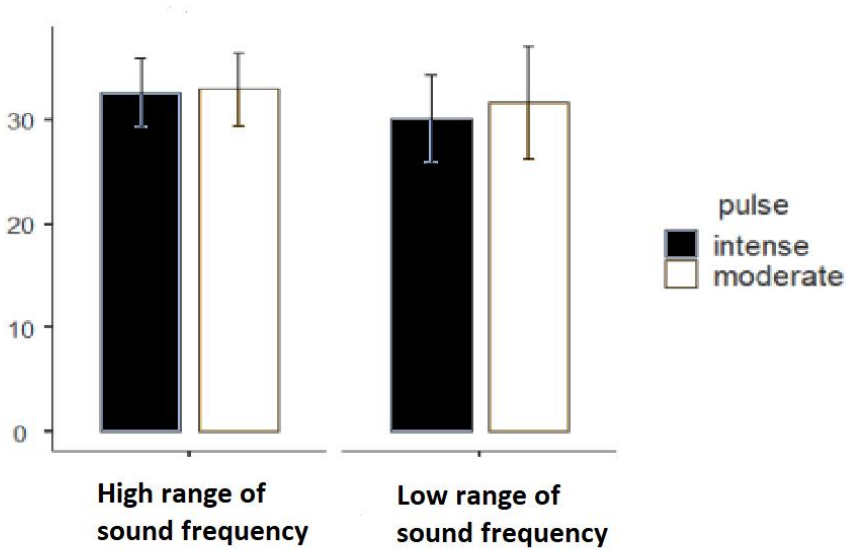
To test the hypothesis on main effect that increased intensity of pulse would lead

to the decreasing of attention and increased range of frequency would result in the decreasing of attention, and on interaction effect that when frequency range decreases and the intensity of pulse decrease, the attention would decrease, I ran some ANOVAs with the data.

The result of the ANOVA in total errors did not reveal a statistically significant result of pulse (Intense: M=31.4, SD=11.9; Moderate: M=32.4; SD=14.1), $F(1,38)=0.0567$, $p=0.813$, $\eta^2=0.001$, nor a main effect of frequency (High: M=32.8, SD=11.0; Low: M=30.9, SD=15.0), $F(1,38)==0.2164$, $p=0.644$, $\eta^2=0.006$. No interaction between pulse and frequency was observed, either, $F(1,38)=0.0225$, $p=0.882$, $\eta^2=0.001$(Figure 2).

Figure 2

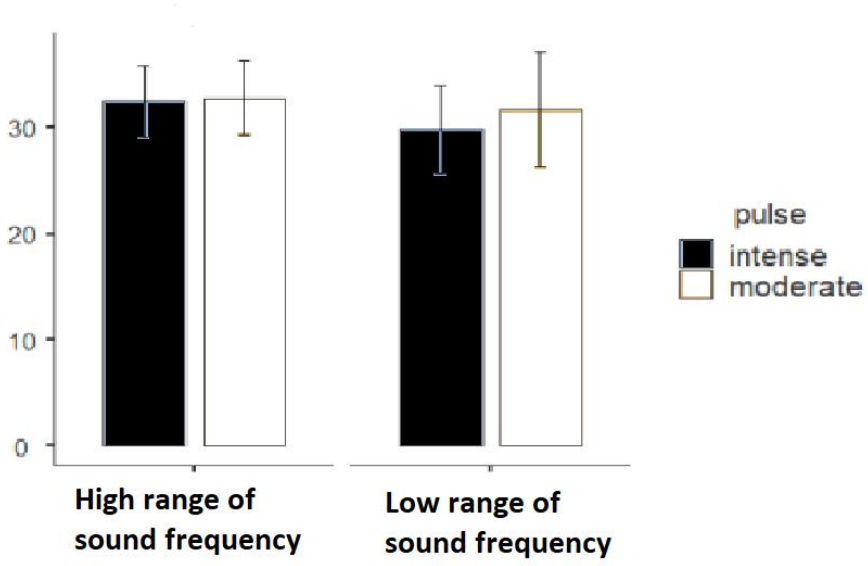
Comparison of the Means of Total Errors



The result of the ANOVA on omissions errors revealed neither a statistically significant main effect of pulse (Intense: M=31.2, SD=11.9; Moderate: M=32.3; SD=14.1), $F(1,38)=0.0754$, $p=0.785$, $\eta^2=0.002$, nor a main effect of frequency (High: $M=32.6$, $SD=11.1$; Low: $M=30.8$, $SD=14.9$), $F(1,38)=0.2094$, $p=0.650$, $\eta^2=0.005$. Similarly, there was no sign of a reliable interaction between pulse and frequency was observed, either, $F(1,38)=0.0347$, $p=0.853$, $\eta^2=0.001$(Figure 3).

Figure 3

Comparison of the Means of Omission Errors

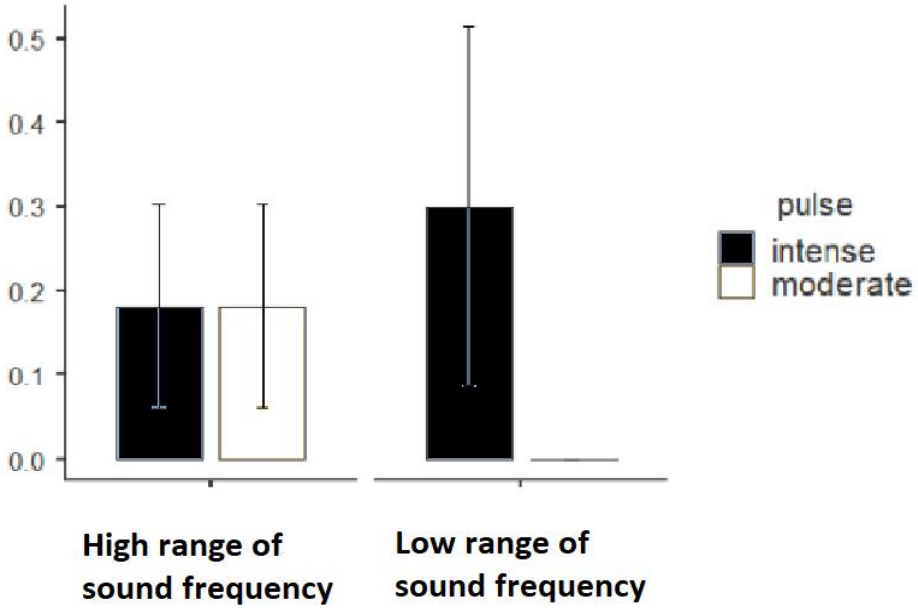


The result of the ANOVA on commission errors still did not reveal a statistically significant result of pulse (Intense: M=0.238, SD=0.539; Moderate: M=0.095; SD=0.301), F(1,38)=1.2149, p=0.277, $\eta^2=0.030$, nor a main effect of frequency (High: M=0.182, SD=0.395; Low: M=0.15, SD=0.489), F(1,38)=0.0547, p=0.816, $\eta^2=0.001$. No reliable interaction between pulse and frequency was observed, either,

$F(1,38)=1.2149$, $p=0.277$, $\eta^2=0.030$(Figure 4).

Figure 4

Comparison of the Means of Commission Errors



Summary

Neither the t-tests nor the ANOVAs revealed any significant findings; in the other words, I lacked sufficient evidence to reject the null hypothesis that music percussion have no impact on people's performance on selective attention.

Discussion

Despite the literature reviewed above, which suggests that music often has a measurable impact on people's attention, I was not able to detect reliable differences on selective attention based on the type of music participants were listening to in my experiment. There are several possibilities for this surprising outcome. I discuss them below.

No Effect

One possibility is that there might no be real effect of musical percussion on people's selective attention. Even though there are a lot of existing results(Chen et al., 2013; Koh et al., 2014; Thompson et al., 2012) suggesting that music has an impact on people's attention; however, there are also other null results in the literature. For example, Chou (2008) found no significant difference between listening to classical or no music on reading comprehension among college students, even though classical music rarely involve percussion and that might not make a huge difference between classical and no music condition in the aspect of musical percussion, however, it could still provide evidence to the statement that background music do not play an essential part in influencing people's performance on selective attention tasks. Also, it has been shown that, when students do short-term memorization the meanings of new Chinese characters, whether the background music with or without lyrics is not sufficiently distracting to disrupt their performance (Li, 2017). What's more, there was no facilitative effects observed on the performance of information-processing

task found for the music condition nor was connected speech a significant distractor (Zimmer et al,1978). Additionally, there were two other study results in studies employing simpler tasks that arrived at similar conclusions (Kaltsounis, 1973; Wolf et al, 1972).

Inappropriate Stimuli

Using inappropriate musical stimuli might also be a factor that contribute to the failure of the study.

On one hand, the sound frequency of the percussion might not have reached the threshold that would have impact on attention. As mentioned above, to minimize the risk of harming the participants' hearing, and for making the music sounds more aesthetic, the frequency range are both set in moderate levels--in the high-pitch conditions, the average sound frequency was around 580Hz, which the pitch is as high as the not D5; and in the low pitch conditions, the average sound frequency around 43Hz, which the pitch is as low as the note F1. Even though there is an interval of over three octaves between the pitch of percussion across these two conditions, the sound frequency is still in the range that often occurs in music. Also, in the melody line of the music stimuli, the highest note is E6, which is in a higher pitch than the high pitch percussion, and the lowest note is A2, which is only an interval of less than two octaves higher than the low pitch percussion. Therefore, the conditions of sound frequency range might be too moderate to have effect on people's performance on selective attention.

On the other hand, the percussion parts of the music in this study are not noticeable enough. Participants tended to pay more attention to the melody line rather than to the beats of the music. When I asked them how they liked the music during the debriefing, most of them said they enjoyed the melody line; some of them could even sing out some sentences (phrases with a specific melodic construction) of the melody line that they especially enjoyed. However, when I asked them how were the beats in the music, few of them could describe it, one of the reasons why this happened might be that a large portion of my participants .There are three possible reasons that I considered as to why this happened: first of all, the main melody is played by piano, which produces notes that are more staccato sounds rather than sustained sounds, and that might make people ignore the percussion parts, especially when a note and a beat share the same starting point; second, I predict that melodies might be detected or remembered more easily than percussion; last, the percussion parts of the music might not being loud enough so that the melody might covered the beats.

Different Variable

Admittedly, there is various of study results provide valid evidences to support the hypothesis that music have impact on the working or study efficiency; however, there haven't yet been a study result explicitly states that it is the musical pulse and the pitch of percussion that have effect on the selective attention, which is involved in working and studying. All of my hypotheses were based on my personally experience and inference from the existing literature. For example, low pitched music has been

found to be better than high pitched music when it comes to facilitating memory (Koh et al., 2014), but that was based on the pitch of the melody, rather than the percussion. Also, it did not directly indicate that it is the selective attention that is involving in the process of long-term memory that is being affected by the pitch. The study did not mention the best type on musical percussion for improve selective attention. Therefore, music may have impact on the process of working and studying, but the element that is effective in music might not be percussion, and the element in studying and working efficiency that is affected might not be selective attention.

Music Environment of Bard College

Bard College is an institute that is consist of the liberal and arts college and conservatory, and there is a bigger population of people studying music here than the average college students. Therefore, the knowledge of music might became a third variable in my study. Some of the participants that is studying at conservatory of is taking music courses told me that they were trying so hard to stop themselves from analyzing the chorus, progressions, or cadences I used when writing this music. Therefore, the tendency of paying more attention to the parts that is involving they profession while completing a test might also be a factor that the study result was not significant.

Limitations

Besides all the possibilities that were listed above, there are two major limitations

in the study that lead to the insignificant result in my study.

On on hand, the sample size in this study is too small. As mentioned in the participants section, due to the time limit, this study planned sample size (a total of 60 participants, 15 in each group, which is already very small), had to be further reduced to 42 in total, resulting in a highly underpowered study. A study with low statistical power not only has a reduced chance of having a test result that is statistically significant.

On the other hand, the samples were not demographically diverse enough. The demographic information of the participants wasn't collected in the study since I wasn't expected that demographic factor would contribute to the unreliability of the study result, however, there were about 80% of my participants were grew up in a Chinese culture background, and that might be the reason why the amount of commission errors that were made in my study was much lower that most of the studies that use d2 test of attention as a measurement of selective attention, since Chinese people tend to be more cautious when it comes to making decisions, while westerners tend to be bolder.

Other Findings

Even though my hypothesis have not yet been proven true of false, there are three interesting phenomena being observed other than my hypothesis in my study.

First of all, people tend to ignore a target item if it is clustered with other target items. The are six places that three target items are clustered together in the d2 test

that I provided(Figure 5), and out of 42 participants, only two of them did not made omission errors here(one participant from Group 2, and one from Group 4, which are the two groups with low pitch percussion). The phenomenon reflects attentional blink, which refers to the fact that when when there are two targets were within approximately 500 ms of each other, people often failed to accurately detect the second of the two targets , even though the first had been correctly detected(Shapiro et al, 1997). That could explain the observation that then it comes to the cluster of 3 three target, about 95% of my participants made omission errors in those six places.

Figure 5

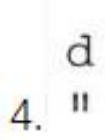
Examples of Clustered Target Items

What's more, people tend to ignore the target item when it is the first item of a trail. The only trail that has the target item in the beginning of the trail is trail 4(Figure 6), and there were 26% of the participants(three of the participants were from group1; 2 from Group 2, 5 from Group 3; 1 from Group 4; and 11 participants in total) made omission errors in this target item. I haven't found a previous literature on why this happen, however, there are two reasons that I've come up with. On one hand, people

might be paying attention to the number labored in the beginning of the trails when they were switching trails. Due to the attentional blink that was mentioned above, the target item that is right next to the number is easily ignored. On the other hand, the attention of the participants might be mainly on the time reminder when they switch to the next trails. Therefore, they did not pay enough attention to the items in the first orders of the trails.

Figure 6

First Item in Trail 4



Last but not least, I noticed that if the participants get a chance to choose their group number(while not knowing what combinations of music percussion those numbers stands for), over half of the participants that was raised in Chinese culture background will chose the number 3, and most of them won't chose number 4. The reason why that happened might be the number 3 is often considered a lucky number in Chinese culture(the mandarin pronunciation of "3" is similar to the pronunciation of "顺", which means "plain sailing"), while number "4" is considered unlucky(the mandarin pronunciation of "4" is similar to the pronunciation of "死", which means "death"). I wonder if there will be a similar phenomenon occurs in people from different culture background, for example, whether westerner might tend to avoid the

number “13” when asked to choose number from 11-14.

Suggestions for future studies

Concluded from the factors that might contribute to the non-significant result and the limitation of this study, I have some suggestions for those interested in this topic and would like to run a study about it.

First of all, the underpowered sample size is the factor that I believe contributed the most to the failure to reject the null hypothesis and leaving a null result. Therefore, in future studies, I would suggest that: 1, have a sample size of at least 25 participants in each conditions if capable, since my original plan was 15 in each conditions, but I was being careless and did not have a plan the possible outliers when I set the ideal sample size, thus, considering the actual sample size might be smaller than original plan due to exclusion of outlier, at least 25 participants in each conditions would be reasonable ; 2, try the best to make sure there are not too much population in the participants that are professional musicians since that might also become a third variable.

Secondly, make sure the percussion is the primary factor in the music. The melody lines in the audio that is provided in my study is too dominant, and the difference of percussion parts were not clear enough to stand out of the melody. Thus, in the future study, the percussion parts should be more vivid by possible about harmless method, such as turn up the volume of the percussion track, make the frequency range to more extreme ends, or compose simpler and more sustain melody

lines.

Last, using several different designs or measurement to make sure the result is reliable. In my study, the only study design is between-subject, and the only measurement is d2 test. From my perspective, using more method to test a hypothesis repeatedly would contribute to a more accurate result. From example, the experimenters could have half of the participants in within-subject design, and rest of them in between-subject group. Also, two different measurement of one dependent variable could be used in the same participants.

Conclusion

In a nutshell, the study did not yield any statistically significant result to support the hypothesis that music percussion have impact on the selective attention of Bard College student. However, it does not indicate that there is not influence that musical percussion have on attention. Considering the small sample size, the limitation of procedure and data analysis, and the fact that all the participants are undergraduate students from Bard College, any finding in this study should not be generalized to larger population. To discover the relationship between this two variable, further studies need to be pursued.

Selective attention plays an essential role in people's study and working efficiency, and music therapy serves as a psychological treatment to help people without involving medication. It would be very beneficial for college students if there is a suitable type of music for students to listen to while studying being found. Therefore, I am looking forward to see that more findings on similar topic in the future.

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Appendix A: IRB Proposal

Section 1

Today's date: 12/10/2021

Name: Lyra Fu

Email: lf0228@bard.edu

Your Academic Program/Department/Office: Psychology

Your status (faculty, staff, graduate or undergraduate student): Undergraduate student

Adviser or Faculty Sponsor (if applicable): Justin Hulbert

If you are a graduate or undergraduate student, has your Adviser or Faculty Sponsor seen and approved your application?
Yes

Your Adviser's or Faculty Sponsor's email address (if applicable): jhulbert@bard.edu

Please list all individuals (full name and status, i.e. faculty, staff, student) involved in this project that will be working with human subjects. Note: Everyone listed must have completed Human Subject Research Training within the past three years. *
Lyra Fu (my faculty advisor, Justin Hulbert, will have access to the data after I collect it)

Do you have external funding for this research?
No

If so, state the name of the sponsor and the title of the project as it was submitted to that sponsor.
N/A

Section 2

What is the title of your project? Does Music Percussion Have an Impact on the Selective Attention of College Students?

When do you plan to begin this project? (Start date): 02/01/2022

Describe your research project: *
Music can be described as pleasant or unpleasant, fast or slow, but can it be described as beneficial to paying attention or not? Music has many features to it, with certain parameterizations leading to a heightened risk of distraction (and, therefore, diminished attention; e.g., Koh et al., 2014; Thompson et al., 2012). Those of us who occasionally study with music in the background may have noticed that certain types of music may actually improve the ability to attend to our work, however. My Senior Project is intended to empirically test the effects on attentional selection of two particular musical factors: the pitch (or audio frequency) and pulse (the number of percussive beats in a measure), holding other factors constant.

Describe the population(s) you plan to recruit and how you plan to recruit participants. Please submit all recruitment material, emails and scripts to IRB@bard.edu *
I plan to recruit 60 healthy adults with normal hearing and vision (and without any diagnosed attentional deficits, e.g., ADHD) from the Bard College community. I plan to make use of printed posters around campus (see Appendix 1 for an example recruitment poster), as well as digital versions of the poster distributed through social media (e.g., Instagram) for the purposes of recruitment. The poster suggests participants either email me to schedule an appointment on campus or to show up during designated times/days when I plan to run many participants in serial (in a quiet room in the Campus Center or Preston Hall).

Will your participants include individuals from vulnerable or protected populations (e.g., children, pregnant women, prisoners, or the cognitively impaired)? *
No

If your participants will include individuals from the above populations, please specify the population(s) and describe any special precautions you will use to recruit and consent.
N/A

Approximately how many individuals do you expect to participate in your study?
60

Describe the procedures you will be using to conduct your research. Include descriptions of what tasks your participants will be asked to do, and about how much time will be expected of each individual. NOTE: If you have supporting materials (printed surveys, questionnaires, interview questions, etc.), email these documents separately as attachments to IRB@bard.edu. Name your attachments

with your last name and a brief description (e.g., "WatsonSurvey.doc"). *
Participants will be randomly assigned into four different groups, based on the audio clip (or "sample") they would listen to while completing a standard measure of selective attention and visual scanning speed: the D2 Test of Attention (Brickenkamp & Zillmer, 1998). An example of the one-page paper-and-pencil test can be found in Appendix 2. Briefly, the test contains an array of letters that include targets (the letter "d" with two lines "‖" in total above or under it) and distractors (e.g., the letter "p" with two lines or the letter "d" with either one line or three lines). Participants have to quickly scan each row of the test, from right to left, and mark as many of the targets as they can find. They have 20 seconds to do so for each trial, and each trial contains 47 letters, of which there are 14 trials/participant total. While engaged in this task, participants will listen to their assigned audio sample using over-the-ear headphones with disposable ear covers (cost about $12 for 100 covers). The melody line of the music samples are all completely the same, with the only difference between them being the percussion layered on top of the melody. Specifically, the frequency of the percussion sound will be manipulated (high = 8k-10k Hz average; low = 150-200 Hz average), as will (independently) the percussive pulse (high = twice a measure; low = once a measure). As these two factors are fully crossed, this design yields four different groups. A given participant would hear the same sample during each one of the D2 trials. Each participant is expected to spend around 10 minutes on this study, including the roughly 4.5 mins of testing and the time for consent and debriefing.

Describe any risks and/or benefits your research may have for your participants.
The experiment involves no more than minimal risk to participants. Attention will be measured under time pressure, and not all individuals feel entirely comfortable with timed tests of any variety. However, the typical student often faces such things in their daily lives. Of course, they will have the option to avoid participation entirely or to withdraw from the study at any point without penalty. And while the audio samples are predicted to, in some cases, affect attention owing to distraction, they were designed with comfort in mind and will be played at a comfortable volume level established with the participant prior to the beginning of the experiment. There are no direct benefits to participants expected; however, they may appreciate contributing to this Senior Project research and learning about how music can affect attention (which will be discussed during the debriefing process). As a token of my appreciation, I will ask interested participants to provide (on a separate document) their name and email specifically for the purpose so that I may contact the winner of a prize drawing for a $100 Amazon gift card.

Describe how you plan to mitigate (if possible) any risks the participants may encounter.
The informed consent process will provide recruits with a description of procedures and materials participants will encounter during the experiment, allowing them to determine if they would be comfortable with the attendant task and listening. I would emphasize that, to be eligible, participants should not have any visual, attention, or

hearing conditions that might make their participation frustrating or irritating (e.g., tinnitus). Furthermore, it would underscore their ability to withdraw from the study at any point without penalty. Prior to beginning the experiment, I will ask participants to adjust the volume to a reasonable/comfortable level using the operating system's built-in sound for volume adjustments. The audio samples, across all four conditions, fall comfortably within recommended health and safety guidelines for frequency, which is 100-12k Hz (Fletcher et al., 2018).

Describe the consent process (i.e., how you will explain the consent form and the consent process to your participants): *
Upon arrival to the testing location, participants will be given the informed consent sheet to examine. I would emphasize that, to be eligible, participants should not have any visual, attention, or hearing conditions that might make their participation frustrating or irritating (e.g., tinnitus). Furthermore, I would underscore their ability to withdraw from the study at any point without penalty. Once they have had a chance to have any questions they might have about the experiment answered, I would ask them to sign the consent form if they indicate that they are eligible and agree to participate. Participants will be offered a copy of the consent form for their records.

Have you prepared a consent form(s) and emailed it as an attachment to IRB@bard.edu? Note: You must submit all necessary consent forms before your proposal is considered complete. *
Yes

If you are collecting data via media capture (video, audio, photos), have you included a section requesting consent for this procedure(s) in your consent form(s)?
No

If your project will require you to employ a verbal consent process (no written consent forms), please describe why this process is necessary and how verbal consent will be obtained and stored.
N/A, I will use written consent with the introduction described above.

What procedures will you use to ensure that the information your participants provide will remain confidential and safeguarded against improper access or dissemination? *
Participants will be identified with an arbitrary participant number on all study documents, except for this consent form and the contact sheet for the prize drawing. These documents will remain separate from the test data collected later in the experiment and will be stored securely in a locked file cabinet, to which only my faculty and advisor and I will have access. Data will be analyzed and presented in the aggregate, with no identifying information included in my Senior Project or related outputs. The consent forms will be retained for the required three-year minimum (45

CFR 46.115).

Will it be necessary to use deception with your participants at any time during this research? Withholding details about the specifics of one's hypothesis does not constitute deception, this is called incomplete disclosure. Deception involves purposefully misleading participants about the nature of the research question or about the nature of the task they will be completing. *
No

If your project study includes deception, please describe here the process you will use, why the deception is necessary, and a full description of your debriefing procedures.
N/A

For all projects, please include your debriefing statement. (This is information you provide to the participant at the end of your study to explain your research question more fully than you may have been able to do at the beginning of the study.) All studies must include a debriefing statement. Be sure to give participants the opportunity to ask any additional questions they may have about the study. *
See Appendix 4.

If you will be conducting interviews in a language other than English, will you conduct all of the interviews yourself, or will you have the assistance of a translator? If you will be using the assistance of a translator, that individual must also certify that he or she is familiar with the human subject protocol and has completed the online training course.
Not applicable

If your recruitment materials or consent forms will be presented in languages other than English, please translate these documents and email copies to IRB@bard.edu. I have submitted all of my translated materials.
Not applicable

Appendix B: Preregistration

Study Information

Hypotheses

Musical percussion do have an influence on people's performance on selective attention. There would be a main effect of music pulse on attention, in that increased intensity of the pulse, would lead to the decreasing of attention. There would be a main effect of music range of frequency on attention, in that increased range, would lead to the decreasing of attention.

Design Plan

Study type

Experiment - A researcher randomly assigns treatments to study subjects, this includes field or lab experiments. This is also known as an intervention experiment and includes randomized controlled trials.

Blinding

No blinding is involved in this study.

Study design

There will be 4 conditions in this experiment. There are two independent variables, which are the musical pulse and the sound frequency of percussion, and each independent variable would have two levels: intense pulse/moderate pulse, and high/low range of frequency. This is going to be a between-subject 2x2 study. The participants would be randomly assigned into four groups. Group 1 with an intense pulse in the high-frequency range; group 2 with an intense pulse in the low-frequency range; group 3 with a moderate pulse in the high-frequency range; and group 4 with a moderate pulse in the low-frequency range.

Sampling Plan

Existing Data

Registration prior to creation of data

Data collection procedures

I plan to recruit 60 healthy adults with normal hearing and vision (and without any diagnosed attentional deficits, e.g., ADHD) from the Bard College community. I plan to make use of printed posters around campus (see Appendix 1 for an example recruitment poster), as well as digital versions of the poster distributed through social media (e.g., Instagram) for the purposes of recruitment. The poster suggests participants either email me to schedule an appointment on campus or to show up

during designated times/days when I plan to run many participants in serial (in a quiet room in the Campus Center or Preston Hall). As a token of my appreciation, I will ask interested participants to provide (on a separate document) their name and email specifically for the purpose so that I may contact the winner of a prize drawing for a $100 Amazon gift card.

Sample size

The participants will be 60 healthy adults with normal hearing and vision (and without any diagnosed attentional deficits, e.g., ADHD) from the Bard College community.

Variables

Manipulated variables

There are two independent variables, which are the musical pulse and the sound frequency of percussion, and each independent variable would have two levels: intense pulse/moderate pulse, and high/low range of frequency. The dependent variable is the selective attention of people.

Measured variables

I will operationalize the variable by the D2 attention test, which is a one-page paper-and-pencil test for selective attention. The standard version of the d2 consists of 14 rows (trials), each with 47 randomly mixed "p" and "d" letters, for a total of 658 letters. The target symbol is a "d" with two dashes (hence "d2"). The participant's task is to cancel out as many target symbols as possible, moving from left to right, with a time limit of 20 s/trial. The score that the participants earn in the d2 test will be measured as the dependent variable.

Analysis Plan

Statistical models

I would run two-tail t-tests with the results, including each group and every two independent variables.

Data exclusion

I will exclude those tests that are left blank.

Transparent Changes

1. Changed sample size from 60 to 42.

   Reason: I was unable to recruit 60 participants due to the lack of time.

   Effect of change on study results: The sample size was too small to yield statistically significant result.

2. Change data analysis from t-test to ANOVA

Rationale: ANOVA is more suitable for testing my hypothesis of main effect and interaction effect than t-test.

Effect of change on study results: None expected.

Appendix C: Recruitment Poster

Appendix D: Consent Form

INFORMED CONSENT AGREEMENT

Title: "Does Music Percussion Have an Impact on the Selective Attention of College Students?"
Principal Investigator: Lyra Fu
Program of Study: Psychology
Senior Project Advisor: Prof. Justin Hulbert
Institution: Bard College

You are invited to participate in a research study investigating the effect of listening to music on your ability to pay attention. In your 10-minute session in this room, you will be asked to wear some headphones (under disposable covers) as you listen to some audio and attempt a paper-and-pencil task in which you search for a target symbol and try to avoid being distracted by other symbols on the page.

To make an informed judgment regarding your decision to participate, you should be sufficiently informed about the risks and benefits of participation. This consent form outlines what you might expect from participating in the experiment. Further instructional information will be provided throughout the experiment, along with opportunities to ask questions. Additionally, I will provide further details about our ongoing research at the end of the experiment, during what is called a "debriefing."

For now, please read the following information and determine whether you are both eligible and interested in participating. When you are ready, you will be asked if you wish to participate. To consent, please complete the eligibility section and sign in the space provided at the end of this form. Please know that you can choose not to participate, and you can choose to end your participation at any time during the study without consequence.

Purpose
I am seeking your consent to participate in a research experiment as part of my Psychology Senior Project. The purpose of this research study is to test how music might affect the attentional ability of healthy college students.

Procedures
Participation in this study involves listening to a piece of music over headphones while completing a paper-and-pencil task designed to test your ability to identify targets of interest while ignoring distractors. You will be asked to complete this process repeatedly in 20-second increments for 14 times over a period of about 4.5

minutes without any pause. Together with the time necessary for instructions and to answer your questions, this whole procedure is expected to take about 10 minutes.

Risks and Benefits

The experiment involves no more than minimal risk. The test of attention that will be used in this experiment is not unlike a timed quiz you might encounter in a class or on the internet. If you would prefer not to complete such a test, then you may decide not to participate. Even if you do begin to participate, you always have the opportunity to withdraw from the study at any point without penalty—just let me know you would like to stop, and we will stop immediately. The music participants will be asked to listen to were designed with comfort in mind and will be played at a reasonable volume level we will establish together before beginning the experiment. One-time use disposable covers will be used over the headphones as a health and safety precaution. There are no direct benefits for participation; however, we hope that participants will appreciate their contribution to Senior Project research and learn more about how music can affect attention. As a token of my appreciation, participants will be offered an entry into a prize drawing for a $100 Amazon gift card. At the end of the experiment, you will be invited to provide your name and email address specifically for the purpose of the prize drawing. This information will not be linked to your data in any way; it is only used so that I may contact the winner of the gift card. The winner will be announced by May 1st, 2022.

Confidentiality

Participants will be identified with an arbitrary participant number on all study documents, except for this consent form and the contact sheet for the prize drawing. These documents will remain separate from the test data collected later in the experiment and will be stored securely in a locked file cabinet, to which only my faculty and advisor and I will have access. Data will be analyzed and presented in the aggregate, with no identifying information included in my Senior Project or related outputs. My final Senior Project will be permanently and publicly available in the Bard College library and online.

Voluntary Participation

Participation in this study is completely voluntary. You are free to decline to participate at this stage, to end participation at any time for any reason, or to refuse to answer any individual question/complete any task without penalty or loss of compensation.

Questions

If you have any questions about this study, you may contact the investigator Lyra Fu (lf0228@bard.edu). If you would like to talk with someone else about any problems or concerns, you may contact my Senior Project advisor, Prof. Justin Hulbert (jhulbert@bard.edu). You may also contact the Bard College Institutional Review Board (irb@bard.edu) if you have any concerns or questions about participant rights.

Eligibility

Participants in this experiment must be: (1) at least 18 years of age; (2) currently studying at Bard College; (3) free from a diagnosed hearing (e.g., hearing loss or tinnitus) or attentional impairments (e.g., attentional deficit/hyperactivity disorder or ADHD); free from any visual impairment that is not corrected by glasses or contact lenses. If you have any questions about these eligibility requirements, please feel free to ask now.

If you are still interested in participating, please indicate whether you are eligible for the experiment, based on all the above requirements by checking the response below:

____***YES***, I am eligible to participate

Agreement to Participate

After reading this document in full and asking any remaining questions you may have, please sign below if you are still interested in participating and eligible.

_____ _____

(your printed name) (today's date)

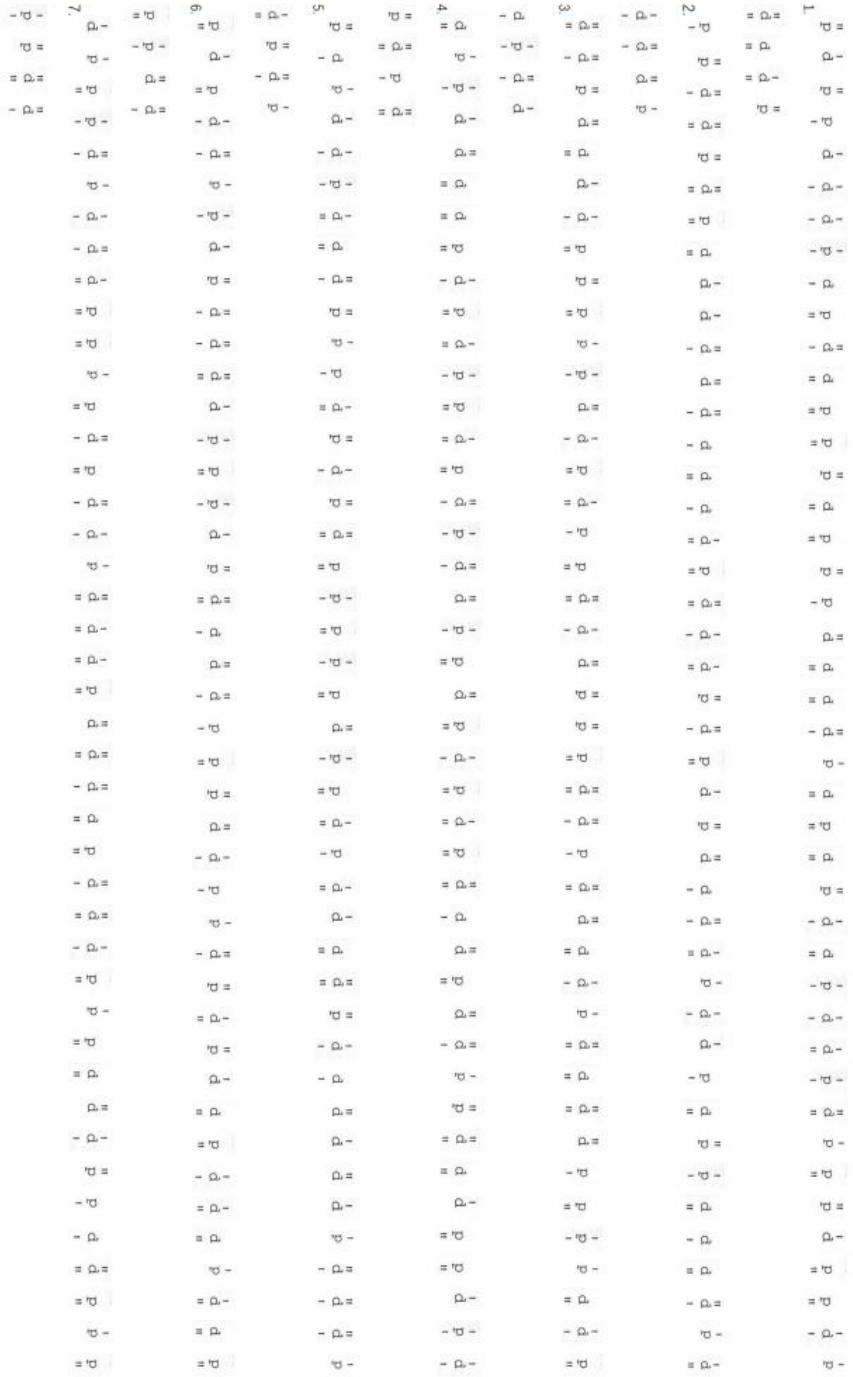
_____

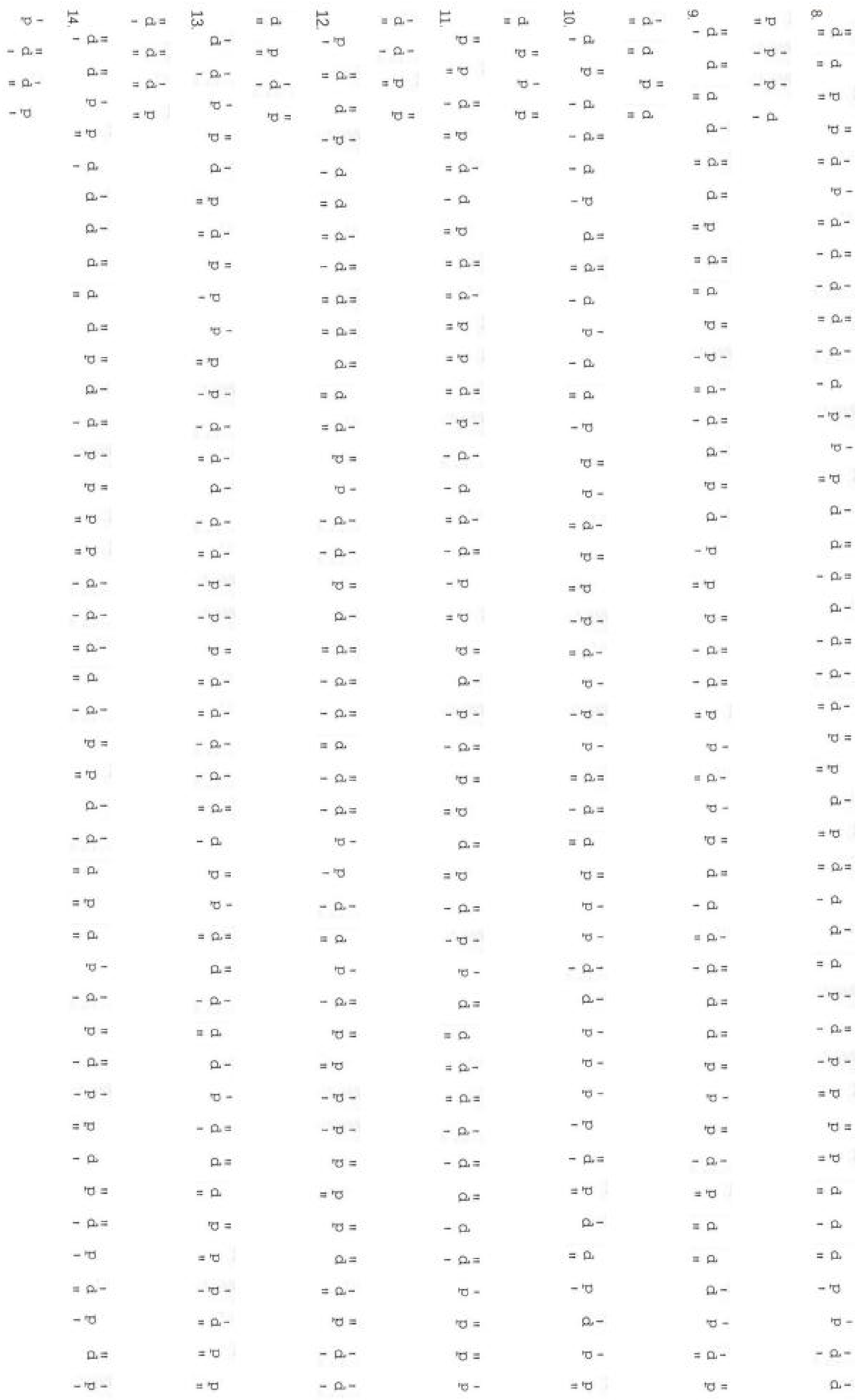
(your signature)

_____

(signature of experimenter)

Appendix E: d2 Test of Attention

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Appendix F: Debriefing Sheet

DEBRIEFING SHEET

Title: "Does Music Percussion Have an Impact on the Selective Attention of College Students?"
Principal Investigator: Lyra Fu
Program of Study: Psychology
Senior Project Advisor: Prof. Justin Hulbert
Institution: Bard College

Thank you for participating in this study! I hope you enjoyed the experience.Before you go, I just wanted to tell you a bit more about why I am conducting this experiment for my Senior Project.

Music surrounds us. It can help express feelings or even change our mood. But can music also affect our ability to focus? If you've ever attempted to study while listening to music, you may have noticed that some music may be more (or less) conducive to maintaining focus. Previous research has identified some of musical factors that affect our ability to focus. Music with lyrics may make it harder to read or remember verbal material, for instance. I'm interested in testing the extent to which two other factors: pitch (how high or low a tone is) and pulse (the numbers of time that the beats appear in a measure) might affect your ability to detect the targets (the symbols you were asked to search for) amidst the distractors (the other symbols) in a standardized test of attention, called the "d2-test of attention".

I predicted that the combination of moderate pulse and high pitch, or the combination of intense pulse and low pitch, will be beneficial for sustaining selective attention. Thanks to your participation—and that of other members of the Bard community who heard different combinations of pulse and tone while working on the d2 test—I hope to reach a conclusion that could afford people advice as to what combination of pitch and pulse facilitates attentional focus.

If you have questions now about the research, please feel free to ask. If you have questions later, please contact the researcher, Lyra Fu(lf0228@bard.edu), or her faculty supervisor, Dr. Justin Hulbert (jhulbert@bard.edu), if you have any further questions regarding the study. If you have concerns about your rights as a research participant, please contact the Bard College IRB at irb@bard.edu.