

Cognitive Performance and Sounds: The Effects of Lyrical Music and Pink Noise on Performance

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Cognitive Performance and Sounds: The Effects of Lyrical Music and Pink Noise on Performance

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Abstract

Given that a large percentage of students listen to music while studying, we investigated whether external noise could impair learning. In the current experiment, participants were tested on their performance in reading comprehension while listening to different types of sound. Undergraduate students ($N = 70$) were asked to read a passage while listening to either pink noise (equivalent to the spectrum of natural sound), pop music (genre of popular music), or read in silence. After reading an informative passage and completing a brief distractor task, participants completed a final test to assess their performance. Afterwards, participants answered questions on their personal study habits. We hypothesized that listening to pink noise while studying would improve cognitive performance compared to listening to pop music or studying in silence. In addition, we predicted that listening to pop music while studying would impair performance relative to pink noise and studying in silence. Results indicated no difference for the different types of sound on performance, suggesting that studying with sound has a minimal impact on learning.

Keywords: learning, pink noise

Introduction

Some of the most common techniques students use for efficient studying may not be the most advantageous. Techniques often used when studying material include highlighting important text, re-reading text, mental imagery or visualization, and summarizing. Dunlosky, Rawson, Marsh, Nathan, and Willingham (2013) examined ten different study techniques and each were assigned a low, moderate, or high utility rating. The utility rating describes the effectiveness and easiness of each learning technique. Highlighting, re-reading parts of a text, imagery, and summarizing what you have read are four of the ten learning techniques reviewed and each were assigned a low utility rating. Thus, students tend to use ineffective study strategies.

The environment in which a student is studying can affect their cognitive functions and impact their learning of material. Previous studies have indicated that 79% of junior high school students reported they like to listen to music while studying (Anderson and Fuller, 2010) and that 59% of college students chose to listen to music while they completed their homework (Calderwood, Ackerman, and Conklin, 2014). As students frequently listen to background music while studying, it is critical to further explain the relationship between sound and cognitive performance. Although listening to background music while studying is prevalent in students, it does not indicate that sound is beneficial to the learning of the student, nor does it suggest it to be detrimental.

Pink noise is a random noise that is found widely in nature and many physiological processes. It is commonly explained as a relaxing sound, relatable to that of a waterfall. Pink noise is also similar to white noise, which is comparable to the sound produced from a nonexistent radio station or TV channel (often known as static).

White noise has a higher and greater structural sound frequency than does pink noise. With a lower frequency, pink noise is equivalent to the spectrum of natural sound and has become of considerable interest to researchers (Papalambros et al., 2017; Sejdíć and Lipsitz, 2013; Zhou et al., 2012).

One study of interest examined the effects of ambient noise, pink noise, and a TV sitcom soundtrack on visual attention. Participants were assessed using a continuous performance test (CPT), a computerized attention task that keeps track of participant's reaction times as well as different types of errors they made. It was found that participants in the pink noise group showed higher CPT scores than the ambient noise group, indicating that participants' attention improved while listening to pink noise as compared to the ambient noise (Wasserman and Segool, 2013). If it is true that pink noise leads to better visual attention, then it may be true that listening to pink noise while studying could lead to better learning.

In the current experiment, participants were tested on their reading performance during which they read a passage in silence or read while listening to either pink noise or pop music. We predicted that listening to pink noise will improve cognitive performance compared to listening to pop music or studying in silence. Calderwood et al. (2014) examined the different types of media-multitasking and distractions that students readily choose while they study. Their results showed that students who did not listen to music during the session had fewer distractions compared to students who did listen to music during the study session. Another study found that most students (74.5%) had lower reading comprehension scores while listening to lyrical music in the background compared with students in a quiet environment (Anderson and Fuller, 2010).

From the speculation that listening to lyrical music while completing tasks that require continuous attention will affect the efficiency of learning, we hypothesized that studying with pop music will impair performance relative to pink noise and studying in silence.

Methods

Participants

A total of 123 undergraduate students signed up to participate and begin the study; however, participants were excluded if they did not finish the experiment ($n = 52$) or if indicated that they had completed the experiment previously ($n = 1$). Seventy undergraduate students (Female = 43, Male = 25, Not Specified = 2) from Northern Kentucky University completed an online study on SONA, a research management software, for extra credit or credit toward a course requirement. Participants' age range was 18-48, and they described themselves as White, Non-Hispanic (74.3%), African American, Non-Hispanic (10.0%), Asian/Pacific Islander (4.3%), Hispanic/Latino (2.9%), or Other (8.6%). Participation for this study was voluntary and participants could decline continuation at any time during the session.

Each participant was randomized into one of three conditions: pink-noise group ($n = 18$), pop-music group ($n = 24$), or silence group ($n = 28$). Participants were asked during the final questions whether or not they listened to music during the study session. In addition, participants identified the type of sound they listened to or if they completed the study in silence. After correcting for potential errors, participants were assigned according to what sound they recognized listening to while reading the passage, if different from their originally assigned condition. The participant groups based on final questions response—pink-noise group ($n = 22$), pop-music group ($n = 25$), and silence group ($n = 23$)—were analyzed.

Materials

All participants read an approximately 1,000 word informational passage about dolphins. The scholarly information about dolphins was derived from Encyclopedia.com. A labeled bottlenose dolphin body diagram inserted within the passage was found using Google Images. The nine labeled body structures of the dolphin diagram included: beak, melon, blowhole, dorsal fin, back, flukes, eye, flipper, and belly. The informational passage incorporated text and a labeled diagram in order to mimic the layout of an educational textbook to better simulate a study-test scenario.

During the passage, participants in the pop-music group listened to two songs: "Counting Stars" by OneRepublic and "Drops of Jupiter" by Train. The songs are classified into the pop music genre which consists of elements from country, urban, rock and other

genres. The songs were selected using the published top 50 "Greatest of All Time Adult Pop Songs" listed in Billboard Magazine, and were chosen from the first ten on the list. Both songs were obtained individually from YouTube as videos and then converted into a combined 8.5 minute MP3 file.

Participants in the pink-noise group listened to 8.5 min of pink noise digitally generated at 24-bit/96 kHz. The pink noise was obtained from YouTube as a video and then converted into an MP3 file. The video selected had the highest amount of views compared to all other pink noise videos on YouTube.

Procedure

All materials and procedures were pre-approved by the Northern Kentucky University IRB. Participants signed up for the study on SONA with an estimated completion time of 30 min. If completed, participants were compensated two credits for participation. Once participants signed up on SONA, they were directed to an external website which displayed the beginning of the experiment. Participants were provided the informed consent form and continued to the next portion of the study if they clicked to agree to participate. Instructions about the nature of the experiment were provided. Participants were asked to wear headphones during the study and to complete the study in a quiet environment. To ensure the functioning of the sound before the passage was presented, participants completed a noise test in which the pink-noise group listened to the first ten seconds of the pink-noise MP3 file, and the pop-music group listened to the first ten seconds of the pop-music MP3 file. Participants in the silence group were not presented a noise test.

During the study phase, all participants were asked to study the passage information which included the dolphin text and diagram for 8.5 min. Pink noise played in the background for the duration of the passage in the pink-noise group, just as pop music played in the background for the duration of the passage in the pop-music group. No sound played during the study phase in the silence group. Participants were asked before and after the passage whether or not they heard the music or pink noise (dependent upon assigned group).

The distractor phase included the game of Tetris as a brief distractor task. Instructions were provided and participants were given two minutes to play. After playing Tetris, instructions for the final test were explained. The final test consisted of nine drop-down questions on the dolphin body diagram and ten multiple-choice questions on the dolphin passage, for a total of nineteen questions. Additionally, survey questions were introduced in which participants reported their personal study habits, music preferences, as well as demographics. Finally, participants were thanked and debriefed about the experiment.

Statistical Analysis

To examine multiple-choice and diagram performance, separate one-way ANOVAs were conducted comparing performance as a function of group (pink-noise, pop-music, or silence) using JASP (Version 0.9) statistical software.. Additionally, a chi-square goodness-of-fit test analyzed participant’s responses regarding which noise they thought best for learning (pink noise, pop music, or silence).

Results

The mean percentage of final multiple-choice performance was analyzed as a function of group (pink-noise, pop-music, or silence; see Figure 1). A one-way ANOVA was conducted using JASP (Version 0.9) statistical software. The results conclude no significant difference of sound on multiple-choice performance, $F(2, 67) = 0.082, p = 0.921, \eta^2 = 0.002$. In other words, listening to external noise while studying had no effect on the performance of final multiple-choice questions.

A one-way ANOVA was conducted to evaluate the mean percentage of final diagram performance analyzed by group (pink-noise, pop-music, or silence; see Figure 1). The results were not significant, $F(2, 67) = 1.198, p = 0.308, \eta^2 = 0.035$, indicating there is no significant difference of sound on diagram performance. That is, listening to external noise while studying had no effect on the performance of final diagram questions.

Participants were asked which type of noise they thought improved learning the most. The majority (78.6%) of participants believed that silence is best for learning, while some participants thought that pop music (12.9%) or pink noise (8.6%) is best for learning (see Figure 2). A chi-square goodness-of-fit test analyzed the distribution of responses and revealed a significant effect, $\chi^2(2) = 64.66, p < 0.001$. Thus, these results pro-

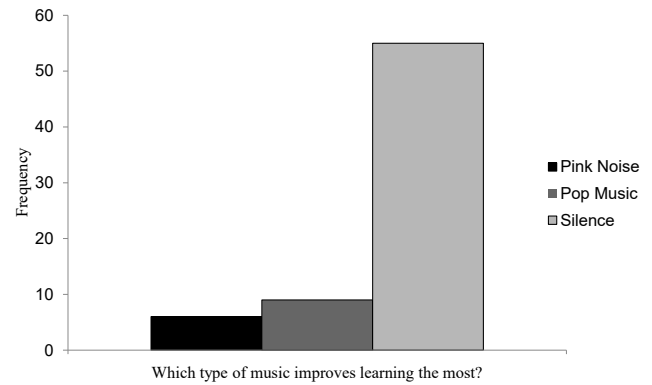


Figure 2. Frequency of responses to specific survey question in comparison between groups (pink noise, pop music, or silence).

vide evidence that sound has no effect on performance, even though students think that silence will improve their learning the most.

Discussion

The present study examined if listening to lyrical music impairs students learning and if pink noise improves students learning. These results show that studying with pink noise, pop music, or studying in silence did not influence performance. However, most students believe silence is best for learning. This is consistent with the findings of a previous study that found participants rated music as more distracting to their performance than silence (Reaves et al., 2016).

The limited capacity model (Broadbent, 1958) explains the negative effects of competitive tasks on concentration. Pool, Koolstra, and Van Der Voort (2003) argue that attempting to accomplish two tasks simultaneously exceeds a person’s capacity for attention and will have limitations on successfully achieving one or both tasks. According to the limited capacity model, listening to lyrical music competes with cognitive tasks required to learn, thus limiting the effectiveness of one or the other. In the current study, there was no difference between silence and listening to pink noise or pop music while attempting to learn information, suggesting that music may not interfere with learning. Although this highlights a situation in which there may be competition for attentional resources, the amount of resources required to listen to music may be relatively small and thus not interfere with learning.

Rideout, Foehr, and Roberts (2010) reported the frequency of teenagers multitasking when using specific types of media. The results indicate that teenagers multitask often, particularly while reading (53%), using a computer (66%), watching television (68%) and listening to music (73%). Due to the high prevalence of multitasking, this research adds a greater understanding of

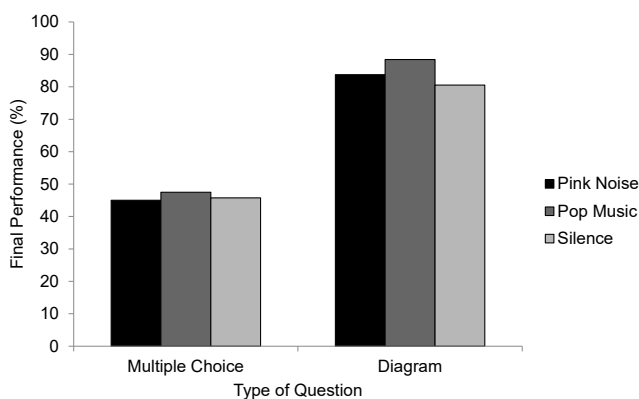


Figure 1. Mean final performance as a function of question type (multiple choice or diagram) and group (pink noise, pop music, or silence).

the importance to investigate potential negative effects on cognitive performance.

As this study was administered online, it was vulnerable to numerous external variables. The testing environment of which the participant began the experiment (e.g. participants in the silence group could have been exposed to noise outside of the experiment) could have affected the results. Participants could alter the volume on their own which led to inconsistent volume levels across participants, while some participants could have disregarded the request to have headphones available before beginning the experiment. In addition, the diagram questions were potentially not challenging enough and so could have caused the exhibited ceiling effect between groups. For that reason, administering this study in a lab-based setting would enable more control over external variables and allow for higher internal validity.

The type of sound that students choose to study with (music, external noise, random noise, etc.) and the manner in which they listen to the sound (volume level, audio source, etc.) could impact their learning. A study found that memorization performance while listening to pink noise at a moderate volume level was better than that under city background noise at a moderate volume level, although performance was not better under loud pink noise (Skarlatos and Georgiou, 2001). If the sound is loud and startling, then sound with more soothing qualities may be a better option for learning. Sound that features a relaxed and consistent melody may be more comforting and not as unexpected.

If a student typically listens to music while studying, this could become a fixed way of learning. If one was never reinforced by music or any noise at all, then they would be expected to complete tasks better in silence because they were never reinforced by a stimulus, other than silence itself. Personal experience could explain why people differ in their judgement of effective study methods. One may think they study more efficiently while listening to music, while someone else may think they study best in silence - and considering their personal experience, both claims may in fact be justified according to this theory.

Individual differences such as personality, motivational interest, and typical study habits should be a focus when investigating cognitive performance. A study found that individual differences such as personality, interest, and motivation were found to have greater influence than test-length for determinants of cognitive ability test performance and reactions (Ackerman and Kanfer, 2009). Additionally, specific factors that may be important to consider would be familiarity of the song, preferred genres of music, lyrical versus non-lyrical music, and other musical characteristics. The differing results between studies could be contingent upon individual differences.

According to the Eysenckian hypothesis, introverts and extroverts differ in their levels of arousal as extroverts have lower levels of excitement and choose environments that provide more stimulation while introverts have a higher level of arousal and do not seek out stimulating environments (Eysenck, 1967). Furnham and Bradley (1997) found that pop music had a detrimental effect on immediate recall and a reading comprehension test for both introverts and extroverts. However, the introverts who performed with music were less able to store the information for later recall than extroverts (Furnham and Bradley, 1997). This indicates that the effects of listening to music while studying may interact with personality traits and could provide an interesting avenue for future research.

Conclusion

The current study aimed to address whether or not pink noise improved learning. Although further investigation is needed to determine the effects of sound on cognitive performance, participants in the current study think studying in silence is best for learning, even though results show that studying with sound has a minimal impact on learning. No harmful or beneficial effects of listening to music while studying were found, nevertheless this is not to imply that music could not ever influence performance. Further research, especially research examining individual differences, is needed to further explore the relationship between listening to music and study performance.

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