Background Music: The Effects of Lyrics and Tempo on Reading Comprehension and Speed

by

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Abstract

The purpose of this research was to assess the effects of lyrical and non-lyrical music on reading comprehension in college students, especially when tempo was taken into consideration. There were several major research questions approached. First, the current study examined a main effect of lyrics, assessing whether lyrical music hinders reading comprehension scores compared to non-lyrical music. Second, it was predicted that there would be a main effect of tempo, such that music with a fast tempo would also hinder reading comprehension scores compared to slow tempo music. Finally, it was predicted that there would be an interaction of lyrics, and tempo with passage difficulty, such that music with lyrics and a fast tempo would hinder reading comprehension the most in the presence of a difficult passage. An experiment was conducted involving 80 college students who completed a reading comprehension task, in conditions involving lyrics with slow tempo, lyrics with a fast tempo, no lyrics with a slow tempo, and no lyrics with a fast tempo, while reading passages at easy and difficult levels. The measured variables included reading comprehension and speed. Results showed that lyrical music was more detrimental to reading comprehension than non-lyrical music, and that harder passage difficulty was more detrimental than easy passage difficulty, however, music with a fast tempo was not more detrimental than music with a slow tempo. Implications of these findings suggest that language and reading comprehension processes of working memory are affected by the language component of lyrical music. These results could aid in launching more research into the study habits of young adults at the collegiate level, and help to create a more successful, healthy learning environment.

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Preliminary Issues

Society is ever-changing and adapting to the newest inventions and technologies brought forth into the world. Today, we are surrounded by an overwhelming amount of technology; because technology is now so easily attainable, it is often misconstrued as a necessity, as opposed to a luxury. With technology readily at our fingertips, it may easily present itself as a distraction, or even interference, in regards to day-to-day cognitive tasks. Social media, texting, television, and even music streaming are just several examples of these technologies that present non-relevant audio and distraction from cognitive tasks such as reading. For example, it is normative to listen to music while doing homework and studying, specifically for adolescents and young adults (Burnett, 2016). However, studies suggest that listening to music in the background can disrupt reading and recall (Anderson & Fuller, 2010; Oakes & North, 2006), but it has also been identified to show a positive impact on emotional reactions and achievements in sports (Kampfe, Sedlmeier, & Renkewitz, 2010).

The disruption of cognitive processes can be best explained through the comprehension of the underlying mechanisms of the working memory system. The working memory system consists of temporary stores with associated mechanisms for rehearsing stored information and a mechanism of central or executive attention that regulates the contents of the active portion of memory (Engle, 2002). Working memory capacity, or executive attention, is most important under conditions in which interference leads to retrieval of response tendencies that conflict with the current task (Engle, 2002). Performance on measures of working memory capacity correlates with performance on a variety of higher-order cognitive tasks involving complex learning,

reasoning, and reading comprehension (Daneman & Carpenter, 1980). These specifications are consistent with the notion that a task such as listening to music would result in an allocation and depletion of attentional resources, resulting in decreased ability for reading comprehension.

Although many studies have shown the presence of background music to be detrimental to cognitive processes (Anderson & Fuller, 2010; Oakes & North, 2006), there is a gap in the literature regarding whether specific types of music have less detrimental effects. While most studies create conditions regarding listening to background music in comparison to a silent atmosphere, there are few sources that apply several musical conditions that account for both lyrical and non-lyrical music. This would be an important contribution to the research that is currently available because it would alleviate possible confounds of previous studies, and provide future accommodations to learners who have shown a preference for listening to music while studying or completing tasks.

In addition to the availability of vocals in music, and the lack thereof, previous studies have also chosen to focus on superficial attributes to music such as preference, familiarity, and genre. Little research has been done to see if the structural characteristics of music itself, such as intensity, timbre, or tempo has an effect on these cognitive tasks (Oakes & North, 2006). As mentioned before, this consideration could improve upon studies that did not take music structure into consideration, and could also provide future accommodations to those learners who have shown a preference for listening to music while completing cognitive tasks.

Alongside the practical implications that this new research could bring are the considerable theoretical implications that could arise. A current potential approach used to explain the impact of background music on reading performance assumes that an increase of

activation in one brain hemisphere decreases the activation of the other hemisphere. With this, it is assumed that if music were to activate the right hemisphere, verbal tasks that activate the left hemisphere would deteriorate (Miller & Schyb, 1989). However, by including tempo and lyrics as variables, new research could determine if there is less interference occurring, and therefore test proposals involving the left and right hemispheres.

Literature Review

Anderson & Fuller (2010) assessed the effects of music on reading comprehension in junior high school students, by using Gates-MacGinite reading tests to score participants' reading comprehension scores while they listened to music vs. when they were in silence. While the results of this study displayed a detrimental effect of listening to music on reading comprehension, only lyrical, familiar music from the Billboard 100 was used as a background music manipulation (Anderson & Fuller, 2010). The conditions did not manipulate passage difficulty, lyrics, or tempo. This supports the need of future research regarding the difference between lyrical and non-lyrical music effects on reading comprehension, at varied difficulty levels.

In an article regarding the effects of background music on reading comprehension in extraverted and introverted participants (college aged, in this case) the only musical type was again both lyrical and familiar—specifically, pop music (Furnham & Bradley, 1997). It was specifically stated that the music was upbeat, and fast paced. The type of music was not varied and tempo was not considered as a specific variable during the experiment. Another standardized test, the GMAT (i.e. Graduate Admission Tests), was used in this study. Like other standardized testing materials, the GMAT also provides selected passages that correlate appropriate multiple

choice questions to assess comprehension. Analysis of the results demonstrated that introverts showed lower reading comprehension scores and memory recall than extraverts in the presence of music, but showed no significant difference in the absence of music (Furnham & Bradley, 1997). It is important to identify, however, that again passage difficulty was not measured, music selection was not varied, and no main effect was found for music.

Another study that similarly assessed the impact of background music and noise on cognitive tests in extraverts and introverts also found that there is a disruption in cognitive processes of both extraverts and introverts in the presence of background music and noise, however, extreme introverts were more poorly affected than extreme extraverts (Dobbs, Furnham, & McClelland, 2011). Again, this study only utilized one type of music for its musical condition: "garage" with lyrics and a fast tempo. Another interesting aspect is that all of the participants were female. This could possibly produce a difference in the results as opposed to if the data had included male introverts and extraverts, as well.

Furnham, Trew, and Sneade (1999) assessed the distracting effects of background music on extraverts and introverts, and compared vocal music, instrumental music, and silent (no music) conditions. Each participant was present in each condition, and completed all of the cognitive tests—including a reading comprehension task, a logic problem, and a coding task. For comprehension, the GMAT standardized test was used. Music did not significantly enhance nor impair reading comprehension scores in comparison to the silent conditions, however a trend showed that introverts were impaired when music was introduced to the environment, whereas extraverts were enhanced by it, especially in regards to the reading comprehension and coding tasks (Furnham, Trew, & Sneade, 1999). It is also important to identify that a main effect was found for extraversion. Additionally, extraverts were more likely to listen to music while

studying than introverts (Furnham & Bradley, 1997). This study suggests that music is not necessarily detrimental to cognitive processes in itself, but that there are possible interactions and variables such as personality or the presence of lyrics, that could contribute to impairment of cognitive processes.

Miller and Schyb (1989) explored facilitation and interference in the presence of background music. The interaction of extraverts and introverts was not addressed, however, the conditions involved not only lyrical and non-lyrical music selections, but also different genres. The conditions consisted of a silent (no music) condition, a classical non-lyrical condition, a vocal pop-music condition, and a non-vocal disco condition. Participants were assigned to only one of the musical conditions but completed every cognitive test, which included reading comprehension, numerical ability, space relations, and verbal reasoning (order of testing was counterbalanced). It was found that performance on the space relations task was facilitated by background music, especially in females. Slight interference appeared on the verbal tasks under some conditions for females, as well. Conversely, background music showed little effect on verbal and reading task performance, however there was an indication that it was associated with less efficient processing for women, specifically (Miller & Schyb, 1989). It is also important to note that vocal music reduced the number of times attempted, which reduces overall reading speed (i.e. less times attempted means less time spent having to read). With this information, we can infer that there is a possibility that background music affects verbal and reading tasks, however, whether the presence of lyrics, or the lack thereof has an impact remains unanswered, and should be addressed in the present study. Also, future studies could take the interaction of gender into consideration, as well.

A few studies have assessed the effects of tempo of the music that is being played. Genre and preference aside, the speed of the music that is being played in the background may have some effect on reading comprehension, as well. Tze and Chou (2010) studied how background music affects concentration in Taiwanese college students, using different genres of music with faster and slower tempos and intensities in comparison to silence. They proposed to test the "attention drainage" effect (Tze & Chou, 2010, p. 44), or the distractibility of the participants. The classical music (taken from the "Chill with Mozart" CD) was used as the slow tempo condition, and the hip-hop music (taken from a "Hip Hop Best" CD) was used as the fast tempo condition. All songs in the classical condition had a slow tempo, whereas all of the songs from the hip-hop condition had a fast and upbeat tempo. Participants were given reading passages from the TOEFL prep book, which supplied reading comprehension questions, as well. There were two experimental groups and one control group: the experimental groups received either classical, and or hip hop, and the control group received no music (silence). All three groups had to read three selected passages, and answer the comprehension questions. It is important to note that the participants in the music conditions were instructed to actively try and ignore the music while they completed the reading comprehension task. Results in this scenario showed that music with higher intensity (i.e. faster tempo) was more distracting and had a greater effect on task performance—specifically reading comprehension and concentration (Tze & Chou, 2010). Hip hop music had a significant effect on the performance of the reading comprehension task when compared to the scores of the participants who performed the task with no music in the background. The classical music group in the experiment also performed slightly lower than the control group (Tze & Chou, 2010). This provides evidence that participant's concentration in both of the experimental groups were more or less affected by background music. While the

results indicate that fast tempo may be more detrimental to cognitive tasks, a major confound is left unaddressed. The classical music used is non-lyrical whereas the hip-hop tracks that were chosen were lyrical. By identifying that the hip-hop music was significantly detrimental, and classical was also slightly detrimental, we must test for the effects of lyrics, or the lack thereof, in future studies (i.e. because this study fails to do so).

The following studies controlled for the differences in genre, and eliminated confounds by taking the lyrical properties of music into consideration. By using the same song, but manipulating the tempo of the track, there is no need to find other songs of equivalent properties. Oakes and North (2006) assessed the impact of background music qualities, specifically tempo and timbre congruity, on recall and affective response. Their participants listened to a non-lyrical song that was played over a radio advertisement. The conditions involved a fast tempo version of the song over the advertisement, a slow tempo version of the song over the advertisement, and the advertisement with no music. Three groups of 38 were used to complete the study- one group per condition. After listening to the radio advertisement during the designated condition, participants were provided with a written questionnaire and instructions. The questionnaire included two questions to measure recall. These questions were multiple choice, and provided five options so as to avoid a floor effect. Further questioning asked the participants to rate how interesting they found the advertisement to be from 1-5. Finally, for those who had participated in a musical condition, a question was asked to determine how enjoyable they had found the music to be. Oakes and North found a significant association between musical tempo and recall, specifically, slow tempo music enhanced ad content recall. Oakes and North suggested that the faster tempo resulted in a distraction from ad message processing. This evidence suggests that

slower tempo music may be less detrimental to other cognitive processes, including reading comprehension.

Kallinen (2002) directly assessed the effects of tempo on reading comprehension by instructing participants to read news from a handheld computer in a distracting environment while listening to background music. This study consisted of three conditions, including fast music, slow music, and no music. The same song (Bach's Brandenburg Concerto No. 2) was manipulated and used for each condition; the original format of the song was operationally defined as the fast tempo condition, and the slowed down version of the song was operationally defined as the slow tempo condition. This adjustment to tempo was done so using the Wavelab audio processing program's time stretch function. The music was maintained at an average volume, and played to the participants through headphones from an MP3 player in a noisy cafeteria. The participants were timed while they read a news story from a pocket browser. Afterwards, they were given 7 true/false questions to answer about the text, and were instructed to evaluate the emotional character of the text.

Contrary to the results from Oakes and North (2006), in which faster tempo reduced recall, Kallinen found that faster tempo music produced more efficient reading comprehension scores than slow tempo. Specifically, reading was most efficient in the fast music condition and most inefficient in the slow music condition, however there was no main effect of music on reading time and efficiency compared to no music. When the two music conditions were compared, it was found that music tempo had a significant effect on reading speed and efficiency (Kallinen, 2002). Reading rate and efficiency decreased when the tempo of the music was slowed down. The difference in this experiment, however, is that the music was presented in headphones in the presence of an externally distracting and noisy environment. Participants were informed to try and actively

ignore the music, so they were not attentively listening to it, rather trying to block out the external stimuli from the cafeteria they were sitting in. In regards to the dependent measures, true or false questions were created to determine participants' comprehension of the related news text instead of a standardized testing material, which could have altered the results.

Thompson, Schellenberg, and Letnic (2011) studied effects of intensity (volume) and tempo, assessing specifically whether loud and fast background music disrupts reading comprehension. This study used strictly classical, non-vocal music (Mozart's Sonata for Two Pianos in D major). Conditions consisted of fast and slow tempos, with either high or low intensities—a total of four conditions. Baseline reading comprehension results (i.e., with no music in background) were established by pilot testing before the experiment to allow for a proper comparison of tempo and intensity effects.

The GMAT was used to determine reading comprehension scores. Participants were given four minutes to read each passage and three minutes to complete the multiple choice questions. They did so while listening to music through headphones; each participant completed a total of four passages, one per music condition (order of conditions was counterbalanced across participants).Comprehension scores were significantly lower than baseline scores in the fast and loud condition (Thompson, Schellenberg, & Letnic, 2011). There was a significant interaction between tempo and intensity. Music that had faster tempo and higher intensity proved to lower reading comprehension scores the most, and music that was slow and/or soft had no significant detrimental effects on reading comprehension. This further expresses evidence that faster tempo is more detrimental to reading comprehension, when combined with a loud volume, and allows further support for interactions among music variables on measures of cognitive processes.

Motivation and Hypotheses of the Present Study

After the analysis of these many studies, it is clear that there is conflicting evidence as to whether or not background music is more or less detrimental in the presence of lyrics. Also, while there is evidence that several factors interact with music to affect reading comprehension, it is not clear to what extent factors such as musical speed and passage difficulty will also impact results.

The reviewed literature provides information regarding the effects of background music on cognitive tasks in regards to using personality factors as an interaction. This is actually beneficial to the proposed study, because it has provided motivation to explore an interaction involved with listening to lyrical and non-lyrical music, from a perspective that is not reliant on personality. The analysis of the different standardized tests available also provides an added necessary element—the inclusion of passage difficulty as a variable. These elements will be beneficial in setting up the design of the experiment itself, and exploring new and interesting interaction possibilities. Future studies would also need to measure and/or control for gender and personality factors such as introversion and extraversion because previous literature has demonstrated that they have an impact.

In the current study, I manipulated lyrics, tempo, and passage difficulty and measured the impact of those factors on reading comprehension and speed. Participants read (and completed comprehension questions for) both easy and difficult passages, while listening to music with or without lyrics, presented at slow and fast tempos. I measured passage reading speed and comprehension accuracy across the conditions. First, it was expected that the presence of lyrical

music would hinder reading comprehension and speed compared to non-lyrical music (cf. Furnham, Trew & Sneade, 1999; Miller & Schyb, 1989). Second, increased tempo has been shown to speed up reading (Kallinen, 2002). I predicted that music with a fast tempo would impede reading comprehension accuracy scores compared to music with a slow tempo (Tze & Chou, 2010; Oakes & North, 2006). Finally, I predicted that lyrical music played at a fast tempo would hinder reading comprehension the most, but only in the presence of a difficult passage. Previous cited research has not manipulated text difficulty as a variable. It was imperative to do so in the current study because by providing an easy passage and a hard passage, we were able to differentiate whether the observed effects are truly due to the properties of the music, and are not just being produced because the passages were easily comprehended.

Methods

Participants

80 participants enrolled in General Psychology at the College at Brockport were recruited to accomplish this study. Participants were required to be at least 18 years old and at the collegiate reading level (i.e. no diagnosed reading deficits).

Materials

To measure reading comprehension, a standardized test was used to provide passages that not only come equipped with correlated comprehension questions, but vary depending on pre-established difficulty levels. Particularly, the Gray Oral Reading Test (GORT) has been used to identify students with oral reading difficulties, determine strengths and weaknesses, evaluate student progress and provide a standardized norm referenced test that is appropriate for conducting reading research (Hall & Tannenbaum, 2013). For the purpose of the present study,

this standardized test was used to assess the reading comprehension levels and speeds of the participants who were under the different conditions.

The GORT was designed to measure reading abilities such as reading rate, accuracy, fluency, and comprehension of students in grades 2-12. The GORT-fourth edition includes updated norms extending from ages 6 to 18 and 11 months (Wiederholdt & Bryant, 2001). Passages are grade-dependent and are selected to coincide with reading grade level. Passages from story 1 are designed for grades 1-3, passages from story 3 are designed for grades 4-5, passages from story 4 are designed for grades 6-9, passages from story 5 are designed for grades 10-11, and finally, passages from story 6 are designed for grade 12 through post-secondary. Each passage is followed by 5 correlated comprehension questions to be answered, which consist of four multiple choice answers to be chosen from. For each correct answer, the participant was awarded a designated point value, to be added to their overall comprehension score per passage (Wiederholdt & Bryant, 2001). For purposes of the present study, grade 5 (stories 5 and 6), from both Form A and Form B, were used as the "easy" passages; and grade 12 (stories 11 and 12), from Forms A and B, were used as the "difficult" passages.

As for the music selections, the songs that were chosen needed to be easily accessible with and without vocals attached. A way to avoid the need of stripping lyrics from already existing songs was by utilizing karaoke, or instrumental versions, of songs that originally contained lyrics from the original track. Four songs were needed for the overall study to accommodate for the counterbalanced design; the songs selected were "If It Means A Lot to You" by A Day to Remember, "Through the Glass" by Stone Sour, "Cigarette Daydreams" by Cage the Elephant, and "Remembering Sunday" by All Time Low. The reason for picking these specific songs is that they were all from the same rock genre, and have similar timbres. The same

songs were found with the lyrics detached and used for the non-lyrical conditions. By using the same songs for both lyrical and non-lyrical conditions, we were able to accurately compare the two without the presence of other variables such as length and genre. It was also necessary to manipulate the tempos of each song, to produce faster versions in comparison to the original, baseline tempo. This manipulation was done using an online website called conversion-tool.com. This software was free, easy to use, and was able to manipulate the tempo of the songs without compromising other key features.

The tempos for the present study were operationally defined as either normal or fast, depending on the beats per minute (BPM) in each song. Using the software, we are able to speed up every song's tempo by 32%, in comparison to the original tempo of each track. After this was done, the BPM for each song was determined by recording how many beats occur within a 20 second time frame, and then multiplied by 3 (to get the total beats for an entire minute).

Two questionnaires were constructed and distributed either post-song or post-experiment to measure variables such as music preference, music familiarity, and personality. The post-song questionnaire assessed whether the participants liked that particular song selection, and their familiarity with it. The familiarity assessment utilized a scale that ranged from 1-5, where lower scores signified greater familiarity, and higher scores signified lesser familiarity, whereas the liking assessment utilized a scale that ranged from 1-7, where lower scores signified greater liking, and higher scores signified lesser liking. The post-experiment questionnaire assessed what kind of music the participants liked, preference for listening to music while studying, and if so what kind. Also, several questions obtained from a personality test were used to measure introversion/extraversion. Each question in the post-experiment questionnaire was scored with separate, appropriate scales and/or scoring techniques.

Design

The research design of the current research study is a 2x2x2 mixed factorial design, with 2 dependent variables-- reading speed and comprehension accuracy. The manipulation of lyrical vs. non-lyrical music was between participants, and song tempo and passage difficulty was within participants. Each GORT passage has 5 accompanying comprehension questions; to increase measurement accuracy we used 10 questions for a given condition. The GORT has two passages at each grade level (i.e. difficulty level) for both Form A and Form B, so we used both passages (5 and 6 for easy, 11 and 12 for difficult) from both forms (A and B) to be able to measure accuracy across 10 questions each in the slow and fast tempo conditions. A total of 40 participants completed the four Tempo X Difficulty conditions (counterbalancing order), with lyrical music, whereas the other 40 participants completed the four conditions with non-lyrical music.

The sequence for the four lyric by tempo conditions was counterbalanced across participants; each song and each passage appeared in all four tempo by passage difficulty conditions. Participants were randomly assigned to participate either with or without lyrics, and they were randomly assigned to one of the four sequences for the tempo and passage difficulty conditions. For a given lyrical condition, songs 1-4 rotated through each tempo by passage difficulty condition so that participants heard a different song for each of the four conditions (regular/easy; fast/easy; regular/difficult; fast/difficult).

Procedure

In the current study, the selection of participants was on a voluntary basis**.** Students were notified about the study and able to sign up electronically via the SONA system. The study was

conducted in a lab on campus so as to maintain a true experimental setting without compromising accessibility to students (i.e. students were easily able to find the lab setting and it is not in a location that is unmanageable or dependent on whether or not they have transportation outside campus). Participants were informed about what is expected of their participation in the study before it started, and assured that they had the right to leave the study at any time for any reason. Incentive was offered to volunteer participants; students who participated in the study received a compensation of 1 point extra credit. Also, the participants were assured that data will remain confidential.

After arrival to the lab, students were directed to have a seat at the table where they were asked to read an informed consent. Upon completion of this task, the instructor escorted the participant to the back of the lab to be seated at a computer, where they were then briefed on instructions prior to participation. GORT passages and comprehension questions were presented individually via the computer, using Qualtrics, which also recorded the time (speed) that the participant spent reading the passage and questions individually. Screens were also included to provide instructions and pages for formal "Stopping Points" to prevent reading ahead (i.e. the program told participants to stop until instructed to move further). Upon clicking the next page arrow (to initiate the timer), participants viewed a passage; they then clicked the arrow again (to stop the timer), and continued the same process to view accompanying reading comprehension questions. For each question they selected an answer among four options. Participants were not to start a passage until the instructor had indicated to do so; when it was time to begin, the instructor turned the selected musical piece on via speakers, and told the participants to begin. The music continued to play until the participants indicated that they had finished both the passage and the associated comprehension questions, and post-song questionnaire (with the

questions that assess the individual's enjoyment of the song and their familiarity with it) for the condition.

The same process was repeated (in a different order across counterbalancing groups) for each of the remaining three music conditions for a given session. After all of the four Tempo X Difficulty conditions were completed, the participants also completed the post-test questionnaire (with the questions that assess the individual's music preferences, preference for listening to music while studying, what kind of music they listen to IF they do, and questions regarding introversion and extraversion). For counterbalancing the order of the four conditions (and their association with the four musical selections) for both the lyrical and non-lyrical components of experiment, the Latin Square design was used. This was to ensure that each song (for both the lyrical and non-lyrical version) across sessions was associated with each of the four Tempo X Difficulty conditions an equal number of times, and that each Tempo X Difficulty condition preceded and followed each of the other conditions an equal number of times.

Results

Means (-and standard deviations) for reading passage times are listed in Table 1. The results for total reading passage time are affected by passage length-- the difficult passages are longer than the easier passages. Due to the nature of this confound, ANOVA for those results will not be reported.

A 2X2X2 ANOVA was conducted to compare the influence of lyrics, tempo, and passage difficulty, as well as the interaction effects between lyrics, tempo, and passage difficulty on reading accuracy scores (i.e. number of reading comprehension questions answered correctly out of a total of 10 possible points). The lyrics factor included two levels (lyrical music, non-lyrical

music), tempo included two levels (fast, normal) and passage difficulty included two levels, as well (easy, difficult). Table 2 includes the means (and standard deviations) for accuracy scores for each conditions. All main effects were statistically significant at the .05 significance level, except for the tempo factor. The main effect for lyrics yielded $F(1,78) = 6.77$, $p = .011$, indicating a significant difference between lyrical and non-lyrical music, where music with lyrics produced lower reading comprehension accuracy scores than music without lyrics. The main effect for passage difficulty yielded $F(1,78) = 112.78$, $p < .001$, indicating a significant difference between easy and difficult passages, where reading difficult passages produced lower reading comprehension accuracy scores than reading easy passages. The main effect for tempo yielded $F(1,78) = .036$, $p > .05$, indicating that the effect for tempo was not significant; music with a fast tempo did not produce significantly lower scores than music with a slow tempo.

The interaction effects between lyrics, tempo, and passage difficulty varied in significance. The interaction effect between lyrics and passage difficulty was significant, $F(1,78) = 4.10$, $p = .046$, where the effect of lyrics was larger for difficult than for easy passages. The interaction effect between lyrics and tempo was not significant, $F(1,78) = 1.95$, $p = .167$. Neither the interaction effect between tempo and difficulty, $F < 1$, nor the interaction effect between lyrics, tempo, and passage difficulty, $F < 1$, was significant. These findings did not support the hypothesis that listening to music with a fast tempo, while reading a difficult passage produces lower reading comprehension scores, nor does listening to fast, lyrical music while reading a difficult passage.

A follow-up analysis was completed using familiarity ratings to assess whether differences in familiarity may be contributing to the effects of music on accuracy (familiarity rating scale ranged 1-5 from extremely familiar to not familiar at all). A 2X2X2 factorial analysis

of variance was conducted to compare the influence of lyrics, tempo, and passage difficulty on familiarity ratings. With familiarity as a dependent variable, there was an interaction between passage difficulty and lyrics where familiarity ratings showed an opposite pattern for the easy and difficult passages depending on whether or not lyrics were present, $F(1,78) = 7.95$, $p < .01$ (See Table 3). However, the main effect of lyrics on accuracy (i.e. the reduction of accuracy for music with lyrics) cannot be fully based upon familiarity because there was no significant effect of lyrics on familiarity, $F<1$.

A follow-up analysis was completed using liking scores to assess whether differences in liking may be contributing to the effects of music on accuracy (liking rating scale was 1-7, with low scores meaning more liking, and high scores meaning less liking). A 2X2X2 factorial analysis of variance was conducted to compare the influence of lyrics, tempo, and passage difficulty on liking ratings. With liking as the dependent variable, there was an interaction between passage difficulty and tempo, $F(1,78) = 6.03$, $p = .016$; there was no difference for easy passages between tempos, but for hard passages, participants liked the song less when it was a fast tempo, $F(1,78) = 8.21$, $p = .005$ (i.e. results showed less liking of music in the presence of hard passages). However, there was no sign of a main effect of lyrics on liking, therefore there is no indication that participants liked the music less in the presence of lyrics, and liking cannot explain the effect of lyrics on accuracy.

Students' preferences to listening to music while studying, or not, were also assessed. Data showed that 61% of student participants reported listening to music while studying, whereas 39% of student participants did not report listening to music while studying.

Discussion

This study explored the effects of lyrical and non-lyrical music on reading comprehension in college students, especially when tempo is taken into consideration. It was hypothesized that there would be a main effect of lyrics, where it was assessed whether lyrical music hinders reading comprehension accuracy compared to non-lyrical music. Participants experienced lower reading comprehension accuracy when listening to lyrical music, which serves as evidence that lyrics affect reading comprehension. This finding is consistent with previous literature stating that background music affects verbal and reading tasks (Miller & Schyb, 1989; Salamé & Baddeley, 1989; Anderson & Fuller, 2010; Oakes & North, 2006). Unlike previous designs, though, the current study addresses variables that were not previously controlled for. Specifically, the current study was able to control particular elements of the music used in each condition such as genre, timbre, and song length to manipulate other musical properties such as the presence of lyrics or the lack thereof. By controlling these elements, the current study was able to isolate and assess this linguistic component of music, and how it affects reading and language comprehension processes. The findings suggest that the lyrical component of music produces interference, resulting in a disruption of cognitive processes—specifically working memory—and lowered ability to comprehend language. This assumption aligns with previous literature regarding the working memory system; depletion of cognitive resources, and interference, lead to retrieval of response tendencies that conflict with the current task, such as reading and language comprehension (Engle, 2002). It is plausible, then, to assume that listening to music with lyrics drains individuals' cognitive resources for language comprehension, and creates interference in such a way that inhibits individuals' abilities to complete other language comprehension tasks.

An interaction was found between lyrics and passage difficulty; listening to music with lyrics while reading difficult passages produces significantly lower reading comprehension accuracy. These findings also align with previous literature regarding interference and depletion of cognitive resources, especially concerning language and reading comprehension (Engle, 2002). It is plausible to assume, then, that language processing occurring while an individual listens to lyrical music in addition to reading comprehension resources being used as the individual reads a difficult passage both contribute to lower reading comprehension scores.

Although this finding is evident, it is important to acknowledge that the evidence that lyrics are particularly detrimental for difficult comprehension situations is weakened by the significant effects observed for familiarity and liking ratings with respect to passage difficulty.

Second, it was predicted that there would be a main effect of tempo, such that music with a fast tempo will also hinder reading comprehension accuracy scores compared to slow tempo music. Participants did not experience lower reading comprehension accuracy when listening to music with a faster tempo, which does not provide evidence that tempo affects cognitive processes. Though previous literature did not show these findings specifically, Kallinen (2002) did find that faster tempo in music produced more efficient reading comprehension scores than slow tempo— contradicting to what was expected of the current study. Contrary to the previous study, the present study utilized standardized comprehension questions, as opposed to the true or false selection of comprehension questions provided in Kallinen (2002). Also, the present study did not subject participants to an externally distracting and noisy environment, unlike previous designs (Kallinen, 2002). The current study alleviated confounds from earlier designs, however, it did not yield expected results due to new, uncontrolled variables, such as the possibility of passage length as an influence on the effects of tempo on reading comprehension accuracy.

Specifically, the current study was unable to adequately test the interaction of tempo and difficulty for reading speed because of the length difference between difficult and easy passages. It is possible, then, that the results found in the current study, though seemingly aligned with Kallinen (2002), may not be supported in the future once these confounds have been alleviated. Even with this consideration, however, it is important to note that comparing conditions that kept passage length constant, while tempos were varied between fast and normal tempos still showed no clear sign of an effect for tempo.

Finally, it was predicted that there would be an interaction of lyrics and tempo with passage difficulty, such that music with lyrics and a fast tempo would hinder reading comprehension accuracy the most in the presence of a difficult passage. Participants did not experience lower reading comprehension accuracy when listening to fast, lyrical music in the presence of a difficult passage, which does not provide evidence that the interaction of these factors is any more detrimental when reading a difficult passage than when reading an easy passage.

Several limitations for this study need to be addressed. First, the overall accuracy rate was low, especially in regards to the college population. The passage difficulty for each condition was selected based on the assumption that participants with a college-level education would perform exceptionally well on reading comprehension tasks obtained from a significantly lower grade level, and would be more challenged by a difficulty level that was consistent with college-aged educational levels. College aged participants did not show adequate comprehension overall; this can potentially be explained by several prospects. One explanation involves the phenomenon of metacognition, or metacognitive knowledge. Metacognitive knowledge is one's stored knowledge or beliefs about themselves and others as cognitive individuals, about tasks, about

strategies or actions, and about how these interact to affect the outcomes of any intellectual initiative (Flavell, 1979). This theory suggests that it is possible that participants were not aware that lyrics were affecting their reading comprehension abilities, and therefore, they did not adjust their cognitive strategies accordingly. Additionally, it is possible that participants rushed through the sessions to finish sooner, and/or did not perform to the best of their abilities, thus affecting the results accordingly.

Second, it is important to note that there was a significant length difference between easy and hard passages. This is concerning, as it affects total reaction time, but also because longer passages cause the participants to be in the presence of music for a longer period of time. This confound weakens the evidence that lyrics are damaging in the presence of difficult passages.

The implications for this study are important not only for future study habits, but it is also targeted to young adults, who often struggle in silence with overwhelming workloads and harmful study habits. This study can help steer more research to this age group in terms of identifying (more vs. less) beneficial study conditions. The results of this study suggest that students who listen to music while studying could benefit from listening to music without lyrics, instead of lyrical music, as the presence of lyrics depletes cognitive resources and reduce reading comprehension abilities. The current study was unable to answer questions regarding the effects of listening to music while studying in comparison to studying in silence, as a silent condition was not included in the experiment. Future research should examine the effects of lyrics, tempo, and passage difficulty on reading comprehension accuracy in comparison to reading comprehension accuracy in silence. New research can also provide an updated look at the topic since much of the previous literature is dated. With an ever-expanding network of technologies, it would be beneficial to extend this area of research to today's students. If these college students

are the future of our world, it is necessary to invest resources in their success any way that we can.

Future research should focus on alleviating this confound of passage length, in an attempt to properly find the effects of tempo on reading comprehension. Additionally, future research should also include a non-music condition, to assess the differences in reading comprehension ability in silence in comparison to the lyrical and tempo- varied conditions.

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Table 1. Mean (and Standard Deviation) Passage Reading Time in Seconds per Condition

Passage Difficulty/ Tempo	Lyrical Condition		Non-Lyrical Condition	
	M	SD	M	SD
Easy/ Normal	70.17	28.85	70.47	32.50
Easy/ Fast	69.59	30.65	66.78	26.65
Hard/ Normal	131.25	67.80	124.46	45.79
Hard difficulty/ Fast Tempo	125.38	64.82	127.33	50.05

Table 2. Mean (and Standard Deviation) Accuracy Scores of Comprehension Questions Out of 10 by Condition

Passage Difficulty/ Tempo	Lyrical Condition		Non-Lyrical Condition	
	M	SD	M	SD
Easy/ Normal	6.68	1.61	7.10	1.41
Easy/ Fast	6.98	1.42	7.13	1.51
Hard/ Normal	4.55	1.92	5.86	2.24
Hard/ Fast	4.65	1.66	5.33	2.20

Table 3. Mean (and Standard Deviation) Familiarity Ratings (1-5, Extremely Familiar—Not Familiar At All)

Passage Difficulty/ Tempo	Lyrical Condition		Non-Lyrical Condition	
	M	SD	M	SD
Easy/ Normal	4.30	1.04	3.80	1.18
Easy/ Fast	4.15	1.23	3.85	1.29
Hard/ Normal	3.83	1.24	3.95	1.24
Hard difficulty/ Fast Tempo	4.00	1.28	4.33	1.00

Table 4. Mean (and Standard Deviation) Liking Ratings (1-7, Like a Great Deal—Dislike a Great Deal)

Passage Difficulty/ Tempo	Lyrical Condition		Non-Lyrical Condition	
	M	SD	M	SD
Easy/ Normal	3.15	1.39	3.03	1.29
Easy/ Fast	3.05	1.47	2.95	1.34
Hard/ Normal	3.13	1.38	3.25	1.28
Hard difficulty/ Fast Tempo	3.63	1.71	3.63	1.51