The Effects of Background Music Style on Mathematical Computation and Reading Comprehension

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Abstract

Due to the increasing popularity of personal digital devices, many students listen to music while they study. It is however a controversial issue whether music listening is helpful to study performance. This study investigates the effects of different types of background music on study performance among college students through lab experiments. Two major categories of study activities - reading comprehension and mathematical computation - were examined for four different treatments of background music style (i.e., soft music, rock music, heavy metal music, and no music). For each student subject, objective measures, such as test scores and heart rates, were recorded for all conditions of the experiment design. Subjective measures concerning treatment evaluations along with personal preference and behaviours on music listening were instrumented in the individual interviews after the experiments. Data analysis on the objective measures indicates that neither test scores nor heart rates of reading comprehension and mathematic computation for different styles of background music are with statistical significance. However, significant gender differences were found and the influences were distinct for the two study activities tested. By further cross-referencing with the subjective measures, our results suggest that, for a better studying performance, college students may choose to listen to background music with preferred music for reading activities but non-preferred music for mathematic computation.

Keywords: background music, study performance, reading comprehension, mathematical computation

1. Introduction and Background

Due to the increasing popularity of personal digital devices, more and more students listen to music while they are studying. It is however a controversial issue whether background music is helpful to cognitive memory or study performance (Bellezza, 1996; Pietschnig et al., 2010). Etaugh & Michals (1975) and Deems (2001) both found that students who normally listened to music while studying scored higher on reading comprehension tests compared to those who usually studied without any background music. Nittono et al. (2000) tested on 24 undergraduates performing a self-paced line tracing task with different tempos of background music and found that fast music accelerated performance compared with slow music. The study of Haynes (2003) indicated that studying to background music did reduce the math anxiety of college students.

On the other hand, Kiger (1989) reported that, for high school students, reading comprehension was best when material is learned in silence and worst in presence of high information-load music. Tucker & Bushman

(1991) found that rock and roll background music decreased performance of undergraduate students on math and verbal tests, but not their scores on reading comprehension. Manthei & Kelly (1999) reported that the music had no statistically significant effect on the math test scores. Burns et al. (2002) suggested that different types of music have different effects on stress. While the analysis does not indicate that listening to classical or relaxing music decreases anxiety, it does suggest that hard rock music may compromise one's ability to relax. However the test scores were not affected by the background music for students with different levels of anxiety. Liu et al. (2012) tested the Mozart effect on Chinese character recognition and found that Mozart's music mainly served as a distracter in such recognition processes. Fassbender et al. (2012) found that, in an educational virtual environment, the effect of background music on memory can be opposite for different display systems. The statistical results of Kasiri (2015) indicated the negative influences of music on reading comprehension performance of Iranian EFL learners, while no significant gender difference was observed. In general, most of these studies suggest that background music act as a distracter to students trying to focus their attentions on study. Furthermore, to understand the influences of background music to studying/learning performance, some possible intermediate or external factors such as music style (Burns et al., 2002; Jucan & Simion, 2015), emotional context (Zhang & Gao, 2014; Deng et al., 2015), gender difference (Andersson et al., 2012; Kasiri, 2015), or environment characteristics (Andersson et al., 2012; Jucan & Simion, 2015) should be considered.

Upon past research the influences of background music to learning performance may still be unclear and seems to have certain connections with personal preference or familiarity to the background music. This present study therefore seeks to re-investigate the effects of different types of background music on study performance in terms of reading comprehension and mathematical computation through lab experiments and further linked with possible individual differences.

2. Method

This study investigates the effects of different styles of background music on study performance through lab experiments. Taiwanese college students with non-music majors are our target experiment subjects. Prior to the experiment, each participating subject was briefed on the purposes and procedures of this study and signed a subject consent form. Each subject was then requested to finish a questionnaire regarding demographic information (e.g., age, gender, and major), frequency of music listening while studying, and one's personal preference on various background music styles.

In the experiment, two major categories of study activities (i.e., reading comprehension and mathematical computation) are examined for four different treatments of background music style (i.e., soft music, rock music, heavy metal music, and no music). In the reading comprehension sessions, subjects are asked to read several short essays (in Chinese) and answer the quiz questions following each essay. Mathematical questions on algebra and equation solving in fundamental high-school levels are instrumented for the math computation sessions. For each of the three background music types, two songs sampled from the pop music market in Taiwan are alternatively played to cover the entire experiment session. A within-subject completed randomized experiment design is therefore instrumented. That is, each student subject was tested on a set of all eight conditions (i.e., the combination of the two study categories with the four background music types) in random orders. Each experiment condition lasted for 30 minutes to ensure the sensitivity and validity of performance measures. These performance or objective measures, such as test scores (the percentages of the correct answers to total quiz questions) and heart rate variation, were recorded for all conditions of the experiment design.

Subjective measures, especially in concerning personal evaluations on experimental treatments and cognitive influences by different styles of background music, were also recorded in the individual interviews after the experiments. The primary interests of these semi-structured post-experiment debriefings include possible distractions by lyrics or singer's image, positive or negative influences on attentions with different music types, and the major cognitive passageways behind those influences.

3. Results and Discussion

Twenty university students with non-music majors in northern Taiwan voluntarily participated in this study. Sixty percent were male (n=12) and 40% female (n=8). Figure 1 depicts the results of average test scores (i.e., the percentages of the correct answers to total quiz questions) under different background music across two study categories as well as genders. In general, as shown in Figure 1, the results of mathematical computation show a somehow distinct pattern from those of reading comprehension. For mathematical computation, gender differences in the effects of background music styles seem prominent. In average, female subjects performed much better with background music than without. In a different pattern, listening to soft background music led to a relatively higher score average for male subjects. Further statistical tests using ANOVA, however, show no significant results in either gender effect ($F(1,72)=0.14$, $p=0.707$) or the interaction effect of gender and music style ($F(3,72)=0.63$, $p=0.598$).

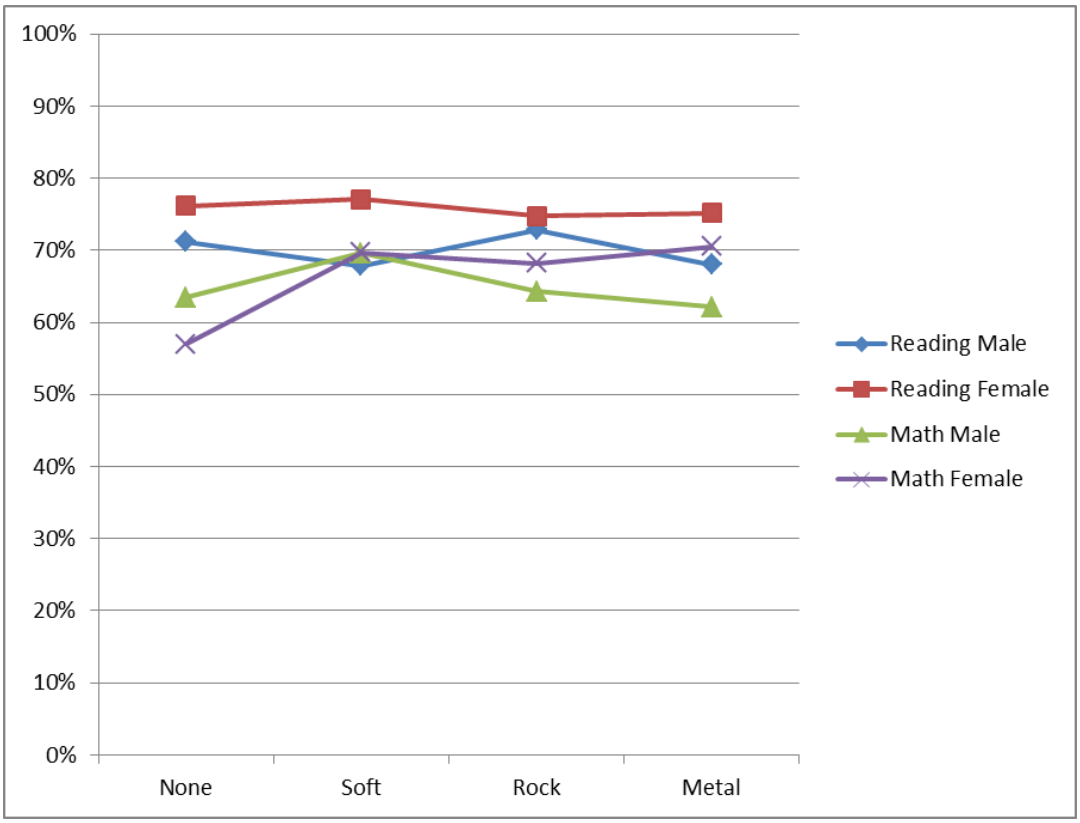

Figure 1. Test performance (in average correct percentage) by different genders under different styles of background music

For reading comprehension, as shown in Figure 1, it is obvious that very limited variation in test performance was found across different styles of background music and genders. However, female subjects seemed to demonstrate a relatively better performance than the male under almost all types of background music. This plot further suggests that, for reading comprehension, the average performance by the female be less sensitive

to music types while the male perform better in listening to rock style music or without any background music. The ANOVA also shows a significant result of gender effect to reading comprehension ($F(1,72)=7.36$, $p=0.008$).

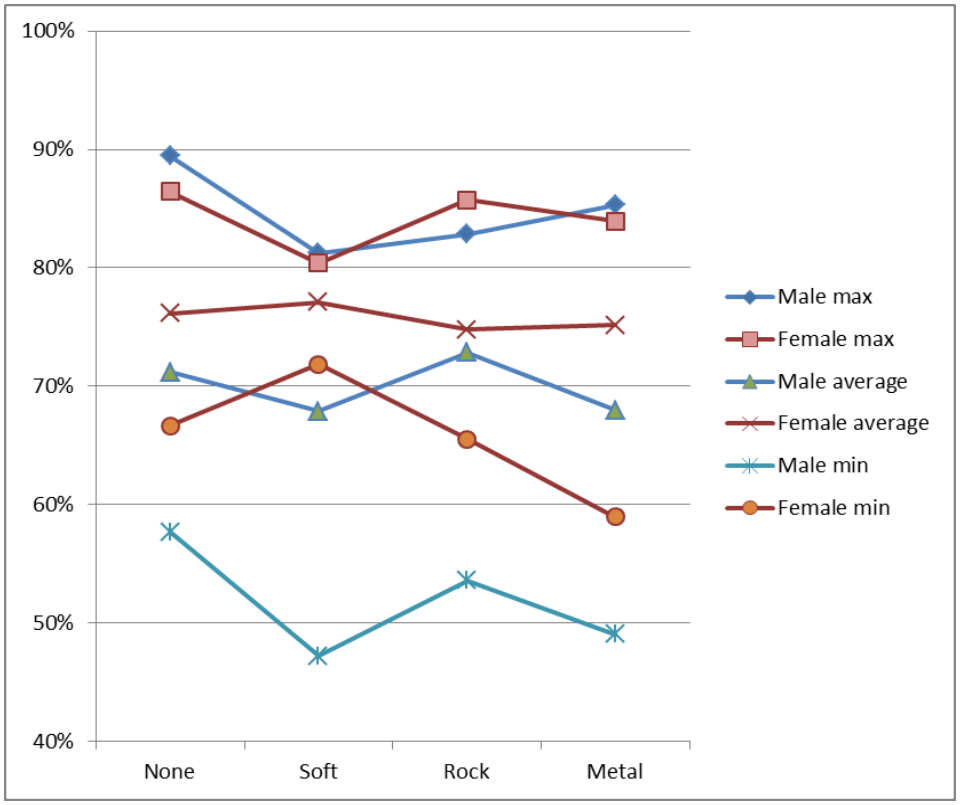

Figure 2. Gender differences in the test performance of reading comprehension under different background music styles

For a closer investigation, Figure 2 depicts the detailed statistical descriptions of gender differences in test performance of reading comprehension under various types of background music. It is obvious that the test performance of female subjects is relatively higher and also less divergent than that of male subjects for reading comprehension, especially in averages and minimums. As also shown in Figure 2, we can further see that the female performance data depict much less individual differences with the soft background music than those with two other BGM styles and without any BGM. On the contrary, providing background music of soft style seemed to result the worst test performance for the male subjects.

As to the measures of heart rate variation, which were the differences (in BPM) between the average HR of the last five minutes in each experiment session to that of the first five minutes, the ANOVA results show no statistical significance except for the gender effect. By further examining the interaction plot shown in Figure 3, it is obvious that male subjects generally demonstrated greater HR elevation than the females did in both reading comprehension and mathematical computation. These data also suggest, mostly, the insignificant impacts to heart rate variations across different background music types. But for male subjects in the math computation sessions, however, soft music showed a prominent HR elevation effect in contrast to other types of background music.

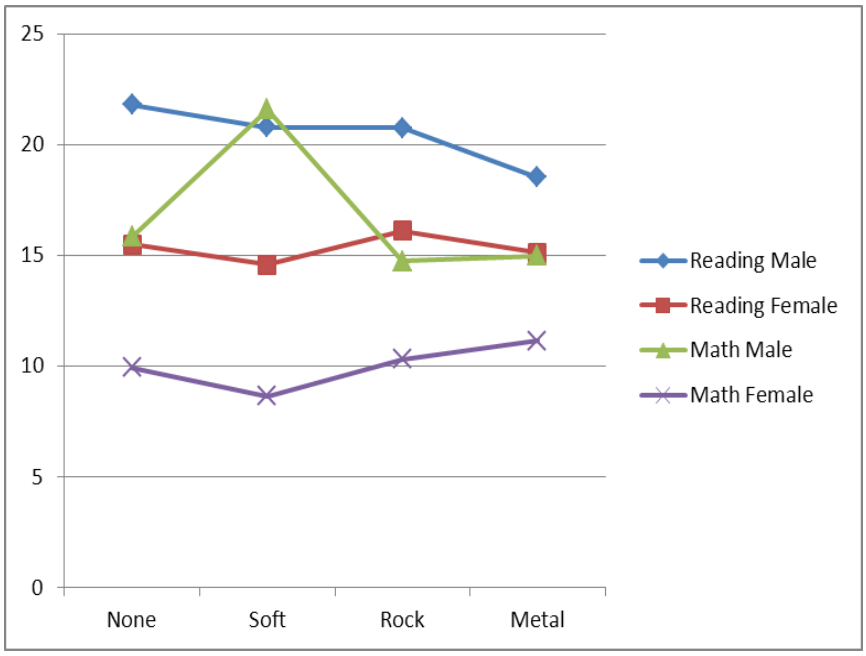

Figure 3. The interaction plot for gender and music type to heart rate variation

Therefore, in general, our analysis suggests that the style of background music show any statistical significance on neither test performance nor heart rate elevation by itself. This result rather concurs with both the findings reported in Manthei & Kelly (1999) and Haynes (2003). The analysis regarding the discrepancy between reading comprehension and math computation in our study, which is depicted in Figure 2, shows similar patterns reported in Tucker & Bushman (1991). Our analysis on the post-experiment debriefings further indicates that the lyrics in all music types, the noisy strong beats in rock & roll, and heavy metal music acted as the primary distractors to focused attentions in study activities. This result seems to well reflect the findings in Kiger(1989) and Burns et al.(2002) as well.

Gender differences seem to play a crucial role in the influences of background music on study performance. For mathematical computation, the female subjects seemed to have better performances with any types of background music than without. In the meanwhile, the male subjects only respond to soft music with better performances and greater heart rate elevations. Therefore, to enhance the study performance in mathematical computation, our data suggest that providing background music may help the female regardless the music style but for the male only the soft music may work.

For the gender differences in reading comprehension, on the other hand, female subjects showed relatively better performances and less individual differences than the male did with or without any background music. The ANOVA result also supported such gender difference. Furthermore, the female were less sensitive to music styles in reading comprehension while the male performed better with rock BGM and worse with soft BGM. It seemed that the female are genuinely better in reading comprehension and background music will not affect the performances. It may also be valuable to investigate further on the fact that soft background music leading to much less individual differences in our female performance data. That is, soft background music seemed to have different influences in different study activities for different genders.

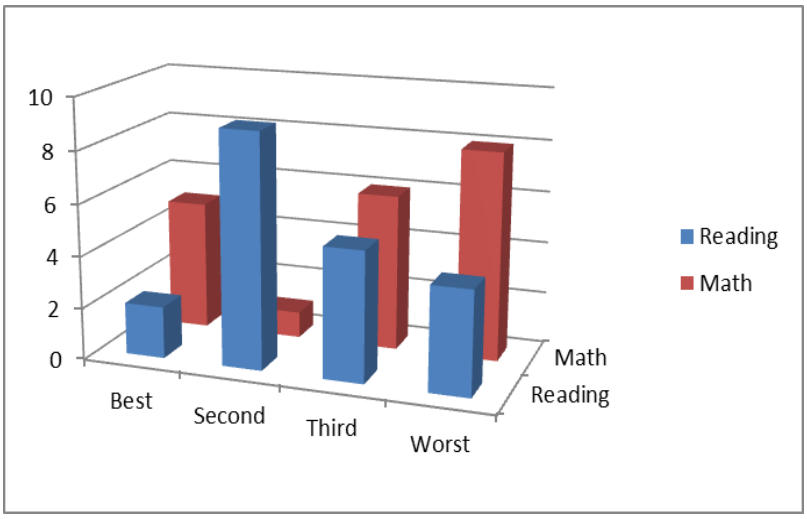

Figure 4. The mappings of test performance rankings to the individual favorite BGM styles

In order to investigate the individual preference effects demonstrated in Etaugh & Michals (1975) and Deems (2001), we cross-referenced the personal preference data from the pre-test questionnaires with the actual performance data collected in the experiments. Figure 4 shows the actual performance rankings of the preferred music type indicated by the individual subjects before the experiments. It is apparent that the results of two study categories did not share similar patterns. For reading comprehension, more than half (55%) of subjects performed better (i.e., ranked best or second) when the type of background music provided was their personal preference. For math computation, in a reverse fashion, more than two-third of the test performance of the preferred music provided actually came in worse (i.e., third or worst ranking), compared to their non-preferred music. In the post-experiment debriefings, several subjects reported that non-preferred music were in fact less distracting and therefore made the focused attention easier for study activities.

4. Conclusions

This study investigates the influences of different styles of background music on reading comprehension and mathematical computation through lab experiments. The ANOVA on the objective measures indicates that neither test scores nor heart rates of reading comprehension and mathematic computation for different styles of background music were of statistical significance. However, a significant gender effect was resulted especially in reading comprehension. To enhance the study performance in mathematical computation, our data analysis on gender differences further suggests that providing background music may help the female regardless the music style but for the male only the soft music may work. It is also found that the female are genuinely better in reading comprehension and the styles of background music will not affect the performances. Our analysis in reading comprehension also reveals that soft background music leading to much less individual differences for the female subjects in particular. Further investigation is thus recommended on the gender effects particular with the soft style of background music. By further cross-referencing with the subjective measures, our results suggest that, for a better studying performance, college students may choose to listen to background music with preferred music for reading activities but non-preferred music for mathematic computation.

5. References

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