

How Does Mozart's Music Affect Children's Reading? The Evidence from Learning Anxiety and Reading Rates with e-Books

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(Submitted October 2, 2015; Revised June 29, 2016; Accepted September 27, 2016)

ABSTRACT

Some music has been proved effectively to mitigate anxiety, beneficial to reading. However, little was known on its influence of reading behaviors and outcomes. Thanks to the advance of e-book technology, it becomes possible to track reading rate and outcomes in a real-time manner by the underlying mobile devices. This study intends to examine the effects of the Mozart piece K.448 (sonata for two pianos in D major) on the learning anxiety, reading rates and reading comprehension of students for reading e-books. The quasi-experimental design was applied, and 62 senior grade elementary school students participated in this experiment. The results showed that when compared with a silent task (reading without the music), this piece of Mozart's music had positive effect in reducing learning anxiety, and improving the students' reading rates, reading comprehension and direct process performance. However, we found that the music had a negative effect on the students' attention for their interpretation process. We inferred that this Mozart's music might take part of attention resource. This was supported by the increase of students' extraneous load while listening to Mozart music, which led to the insufficient concentration in the interpretation and the evaluation of content. Overall, the findings reveal that the use of certain music, such as Mozart K.488, can be a potential tool to enhance reading outcomes when using e-books.

Keywords

Mozart music, Learning anxiety, Reading rate, Reading comprehension, E-books

Introduction

Reading is the foundation of lifelong learning, and is an important indicator of national competitiveness (Lin, Liu, Lin, & Li, 2008). In recent years, the Taiwanese government has been committed to promoting the implementation of primary and secondary school reading programs (MOE, 2007), with the aims of improving primary and secondary students reading abilities, and creating a user-friendly environment to attract students' interest in reading (MOE, 2007), which is essential for enhancing reading comprehension. Some studies have explored ways to improve reading abilities through stimulating students' interest in reading, such as the use of reading strategies (Khowaja, & Salim, 2013), curricula and instruction (Schünemann, Spörer, & Brunstein, 2013; Huang, & Chiu, 2015a; Huang, & Chiu, 2015b), and the use of technology (Huang, & Liang, 2015; Ponce, López & Mayer, 2012; Liang & Huang, 2014; Huang, Huang & Wu, 2014). The development of e-books, which are usually equipped with multimedia functions, has attracted the attention of many educators (Huang & Liang, 2015). The Ministry of Education of Taiwan has carried out a series of pilot plans for e-books (MOE, 2009, 2010), in hope of enhancing the effectiveness of teaching and learning through related technologies. Many scholars have shown the positive effects that can be achieved by introducing e-books to teaching or learning practice (Korat & Shamir, 2008). It is thus expected that instructors should be able to take advantage of e-books to build a better or more innovative reading environment.

Stages of reading development and anxiety

Chall (1983) stated that the development of children's reading may be segmented into five stages, with 9-14 year-old students in the "Reading for Learning New Information" stage. Students in this stage usually have a single viewpoint when reading, and obtain new information from a reading process. Gunning (1996) claimed out when high-grade elementary school are in this stage the purpose is not only to learn how to read, but also for them to expand their knowledge based on the reading methods used. Therefore, textbooks used by higher-grades are longer and more difficult than those used by lower-grades. Wu and Lai (2007) noted that anxiety affects

students' learning processes, and excessive anxiety would interfere with their cognitive processes (Wood, 2006), leading to relatively poor learning outcomes. Since they are dealing with more difficult learning material, higher grade students tend to encounter more challenges that are different from those seen in their past reading experiences, and thus may produce a considerable degree of anxiety. However, some studies have claimed that an appropriate level of anxiety can promote learning, with only excessive anxiety having negative effects (Chang, 1999; Vickers & Williams, 2007). Although some studies have shown that e-book can have a positive impact on reading abilities when integrated into reading instruction (Korat & Shamir, 2008). Additionally, Lam et al. (2009) emphasized that the phenomenon of eBooks is quite different from the traditional books in use today. Wu et al. (2011) also argued that the use of such technology might compromise learning outcomes, since students have to learn how to operate in different learning contexts, regardless of an individual differences with regard to technology acceptance or adaptive ability. Therefore, how to effectively reduce the anxiety of higher grade elementary students, and further promote the development of their reading abilities by the use of e-books, are two issues worth exploring.

Use music to reduce anxiety

As anxiety can harm an individual's performance (Vickers & Williams, 2007), some studies have explored the effects of using music to mitigate anxiety (Shen, Wang & Shen, 2009). For example, Qin et al. (2014) demonstrated that listening music as a way can compensate negative emotion of students. Dolean's (2015) study explored the effect of music on students' anxiety during the regular language classes, and found that music could reduce students' anxiety. In order to assess the effects of music on examination anxiety, Lai et al. (2008) conducted a series of experiments with thirty-eight students randomly assigned to a music or a silent group. The students in the music group listened to a slow piece of music and then received a test, while the students in the silent group took a test without listening to any music beforehand. The results showed that the anxiety of the experimental group was lower than that of the control group, implying that slow music helps reduce anxiety. Dosseville et al. (2012) investigated the influence of music on 249 undergraduate students. The experimental group students listened to classical music during a lecture, while the control group listened to the lecture without music. The results indicated that the performance of the experimental group was significantly higher than that of the control group, indicating that classical music can have a positive influence on learning performance. de Groot (2006) also found that more learning occurred in the music condition (classical music) than in the silent condition when students were learning language vocabulary. Hall (1952) pointed out that reading comprehension among eighth and ninth graders improved in the presence of background music. Rauscher et al. (1993) explored the impact of using Mozart's sonata for two pianos, K.488, on the performance of undergraduate students. The findings showed that this music could help the students' spatial reasoning abilities, with average score of the experimental students being 10 points higher than that of the control group. A phenomenon called the *Mozart effect* was thus proposed, which led to a number of subsequent studies. For instance, Campbell (1997) also used the same Mozart's piece to help patients reduce anxiety. Jaušovec et al. (2006) found that this music could also help to enhance students' learning. These earlier studies suggest that Mozart's sonata for two pianos, K.488, has a positive impact on reducing anxiety and promoting individual learning. In addition, Shih et al. (2012) pointed out that, compared to adagio or classical music, music that contains lyrics may have a negative impact on learning concentration and efficiency. Pring and Walker (1994) noted that music with lyrics interferes with other brain processes. Xing et al. (2016) found that rhythm of Mozart's piano sonata K.448 is the crucial factor of Mozart effect. Besides, Xing et al. (2016) also suggested that different music may have quite different to opposite effects. Therefore, in order to mitigate the anxiety of students and enhance their performance, teachers should consider using appropriate background music, such as s Mozart's sonata for two pianos, K.488.

However, music can also be a negative factor to students' learning, learning environment and learning anxiety (Dolean, 2015) when the instructor integrates music into regular learning activities. Sweller (2010) claimed that cognitive load theory could be distinguished between two sources of cognitive load, namely intrinsic and extraneous load. Reedy (2015) emphasized that the intrinsic load of a learning environment or task is concerned with its inherent difficulty for a learner. Moreover, either poorly designed learning experiences or learning environment will increase extraneous load (Reedy, 2015). Based on cognitive load theory, Schellenberg (2005) claimed that background music may affect human's cognitive load and task. Thus, the effect of background music on cognitive load when students are reading e-books is an issue worth exploring.

Based on these earlier works, this study examined the three following research questions. (1) Can Mozart reduce the learning anxiety of students when they are reading e-books? (2) Does Mozart enhance the reading comprehension of students when they are reading e-books? (3) Does Mozart affect the cognitive load of students when they are reading e-books?

Anxiety, task efficiency and reading rate

Some studies have shown that high anxiety is associated with lower task efficiency (Tanaka, Takehara & Yamauchi, 2006). Byrne and Eysenck (1995) also found that the task efficiency of subjects with high anxiety was lower than that of the low-anxiety subjects. Seliger (1972) found that students with low levels of anxiety had faster reading rates. Gifford et al. (1966) claimed that anxiety is also seen in the behaviors of learners, with the reading rates being negatively related to the level of anxiety. For this reason, this study adopted Mozart's sonata for two pianos, hereafter K. 488, in the learning activities to investigate its impact on the students' anxiety, with the students' reading rates used as the focal performance indicator. The traditional approach in such studies is to use cameras to record learning behaviors and reading rates. However, this method is time-consuming when tracking the learning histories of many students. In contrast, Huang and Liang (2015) used the touch screens of tablet computers to record the e-book reading rates of students, and the results showed that this was able to produce accurate results. This approach can only track reading rates in real-time, and enable instructors to easily see the indications of the learning anxiety of individual learners. The fourth research question examined in this work is thus: Is there a relationship between learning anxiety and reading rates when students are reading e-books without music?

Goals and hypotheses of the current investigation

As noted above, previous studies have found that Mozart's K.488 can reduce anxiety and improve learning. This study thus explored the impact of this piece of music on the learning anxiety, cognitive load, reading rates, and reading comprehension of learners using e-books, based on the following hypotheses:

- Hypothesis 1. Learning anxiety will be reduced when students are reading e-books with Mozart's K.488 as background music.
- Hypothesis 2. The intrinsic load measures are not significant between silent task and Mozart music task when students are reading e-books.
- Hypothesis 3. Extraneous load will be increased when students are reading e-books with Mozart's K.488 as background music.
- Hypothesis 4. Reading comprehension will be enhanced when students are reading e-books with Mozart's K.488 as background music.
- Hypothesis 5. Learning anxiety and reading rate are negatively correlated with each other when students are reading e-books without background music.

Method

Participants

At the beginning of the experiment, 66 senior-grade students (37 males and 29 females) in an elementary school in southern Taiwan were recruited to participate in the learning activity. By excluding those who did not finish the whole process, 62 sets of valid experimental data were collected for analysis. The details of the participants are shown in Table 1.

Table 1. The details of the participants

Participants	All participants	All participants without invalid data	
		Group I	Group II
Male	37	19	15
Female	29	15	13
Total	66	34	28

Experimental environment and tools

The reading materials were three articles of Chinese expository prose produced by the Taiwanese government for use in elementary schools (MOE, 2011), the titles of which were "Pigeon," "The Glacier" and "Rock Climbing." The first article ("Pigeon") was used to conduct the pre-test. The second article ("The Glacier") contains 1,206 words, and the average sentence contains 10.95 words, with 99.42% of these from the list of 5,021 common Chinese words for elementary school students (MOE, 2000). The third article ("Rock Climbing") contains 1,199 words, with an average of 11.1 words per sentence, and 99.58% of these are from the same set of common words.

Both texts (“The Glacier” and “Rock Climbing”) were slightly above the students’ reading ability, in order to ensure that they were appropriate for use in this context with regard to the students’ word recognition abilities, thus preventing a ceiling effect. Furthermore, in order to control for the influence of extraneous variables, and record the students’ reading rates accurately while reading, all reading materials were text-only (excluding the cover).

We used the Android version of Office Suite installed on tablet computers as the reading software. Previous studies indicated that elementary school students often could not easily focus on the text, and some teachers adopt a pointing strategy to require the students to use a finger to follow what they are reading (Chen & Chang, 2011; Huang et al., 2014). Thus, a program was developed to follow the movement of each student’s fingers on the touch screen in order to measure the reading rate, this method also echoing the students’ previous reading experiences. To track the reading rates, all students were asked to use a finger to follow the text on the touch screen when they are reading, and the system then recorded the words read per minute.

In order to ensure that students of group I and group II have the same reading ability before learning, this study used a reading comprehension test (The first article: “Pigeon”) as pre-test to compare reading comprehension of the students of both groups and see whether their reading abilities are consistent. The comprehension test for “Pigeon” has 14 questions with a total of 21 points. The result of the pre-test shows that $t = 1.176, p > .05$, and the pre-test results of both direct and interpretation process shows that $t = 1.341, p > .05$; $t = 0.523, p > .05$, respectively. With no statistically significant difference, which indicates that group I and group II have the same reading ability before learning; therefore their reading abilities can be regarded as consistent.

In learning task, we used a reading comprehension test for each article (“The Glacier” and “Rock Climbing”) to examine students’ reading comprehension when students finished their learning tasks. The comprehension test for “The Glacier” has 13 questions with a total of 18 points, including seven multiple-choice questions (7 points) and six short-answer questions (11 points). The comprehension test for “Rock Climbing” has 14 questions for a total of 18 points, with seven multiple-choice questions (7 points) and seven short-answer questions (7 points). The difficulties of the questions for both tests range from 0.6 to 0.7, categorized as easy to mid-level difficulty. In other words, both comprehension tests were suitable for to assess the students’ reading comprehension in this study. In order to ensure scoring validity, we invited two experts, who are teachers in an elementary school, to serve as raters and assess the short-answer questions according to the scoring guides for each test. After the two raters examined the tests, we examined the inter-rater reliability using Pearson’s product-moment correlation coefficient. The inter-rater reliability ranged from 0.86 to 0.95 ($p < .01$), thus indicating good reliability (Chiu, 2009).

We revised leaning anxiety scales from two previous studies (Venkatesh, 2000; He, Chang & Liu, 2010) to measure the participants’ learning anxiety. The scale consisted of eight questions that the students answered when they had finished each learning task. The responses to all questions were on a four-point Likert-scale, ranging from 4 for strongly agree to 1 for strongly disagree, with higher scores indicating less learning anxiety. The internal consistency and reliability were tested by the Cronbach’s alpha coefficient, and the result for the sample as a whole was .836, indicating that the scale was acceptable, with good internal consistency and reliability.

This study used the scale of cognitive load designed by Ouyang et al. (2010) to analyze the cognitive load of all students. The scale consisted of 5 items of questions that were used to access the score of students’ cognitive load when they finished each learning task. Responses to all questions were on a four-point Likert-scale, from 4 for strongly difficult to 1 for strongly easy, thus the score range of cognitive load was from 5 to 20 with higher scores representing higher cognitive load.

Experimental design and procedure

Learning anxiety and cognitive load were the situational variables of the subjects taking part in this study, and the learning anxiety and cognitive load of individual participants are correlated could not be determined prior to experimentation. With this limitation, this study used the quasi-experimental design, with the same number of subjects receiving each experimental manipulation to explore the impact of Mozart’s K.488 on learning anxiety and reading comprehension. However, the use of the same group of subjects in the experimental activities may cause some bias in the results, due to practice and aging effects, so we adopted the following strategies to reduce the impact of correlation effects: using texts and tests with the same difficulty to avoid the practice effect, and shortening the experimental time interval to one week to reduce the aging effect. The learning task with the Mozart background music was referred to as the “music task,” and that without the music as the “silent task.”

In addition, we used two groups of participants with both groups following the same experimental procedure. In order to enhance the internal validity and reduce the impact of the differences of reading materials, each group was assigned to read the same articles but in different orders. In the first silent reading experiment, while group I read “The Glacier,” group II read “Rock Climbing.” One week later, in the music task, group I read “Rock Climbing” while group II read “The Glacier.” The experimental design is shown in Table 2.

Table 2. Experimental design

Task	Test	Time interval	Task	Test
T ₁	O ₁	X	T ₂	O ₂

Note. X: The interval time is a week; T₁: All participants read the material without Mozart; T₂: All participants read material with Mozart; O₁, O₂: Test (learning anxiety, cognitive load, and reading comprehension).

In order to explore the impact of Mozart’s K.488 on the students’ learning anxiety, cognitive load and reading comprehension, a series of experimental activities were used, and the details of these are shown in Figure 1.

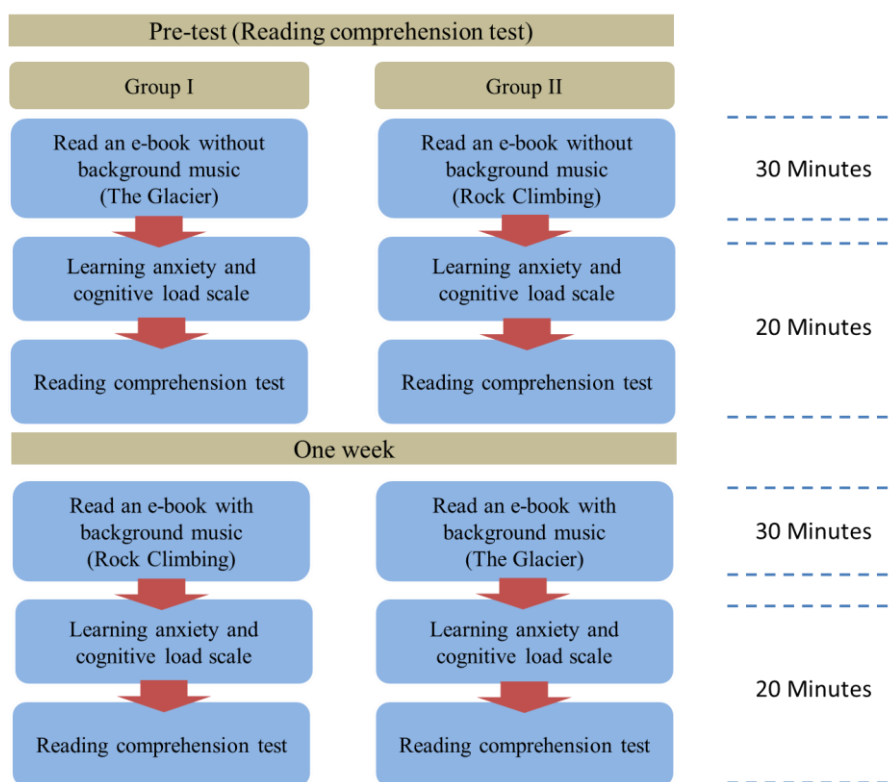


Figure 1. Experimental procedure

Based on the experimental design, the experimental procedure was divided into two main phases: (1) Reading e-books without Mozart, and (2) Reading e-books with Mozart. Each phase contained reading and test tasks. At the beginning of the experiment the students were given instructions with regard to the assigned tasks to avoid the Hawthorne effect.

In the first phase, the silent task was 30 minutes of reading, in which group I was assigned to read “The Glacier,” and group II was assigned to read the “Rock Climbing.” Before the task, students were asked to read the article carefully and pay attention to the text so that they could clearly understand the main points. Upon completion of the reading task, the students were asked to complete the learning anxiety scale and a 20-minute reading comprehension test. Moreover, all students were asked not to read the article content during the reading comprehension test. After finishing the test, the first phase of “Reading e-books without Mozart” was completed. After one week, the second phase also proceeded with a reading followed by a test, as in the first phase, except that Mozart’s K.488 music was playing during the reading task, with group I reading the “Rock Climbing” and group II reading “The Glacier.”

In order to let the students be able to listen the Mozart’s music without any interruptions, the door and windows of the classroom were closed during the related learning task, and each student’s personal computer and speaker were used to play K.488.

Results

Learning anxiety, reading rate and cognitive load

As seen in Table 3, the learning anxiety scores of both groups when Mozart was played were significantly higher than those seen for the silent task, and thus the students' had lower learning anxiety when listening to this music. This result provides support for Hypothesis 1.

As for the reading rates, we found that those for the music task were higher than those for the silent task. The results thus indicate that listen to Mozart's K.488 as background music can indeed affect students' reading rates.

Table 3. *t*-test results for learning anxiety and reading rate

Variables	Silent task			Music task			<i>t</i>	<i>d</i>
	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>		
Learning anxiety								
Group I	34	23.50	4.13	34	25.41	4.59	2.319*	0.43
Group II	28	22.96	4.26	28	26.54	4.76	3.148**	0.79
Reading rate(wpm)								
Group I	34	282.58	10.09	34	291.12	11.74	3.219**	0.78
Group II	28	282.21	10.14	28	289.93	9.66	2.627*	0.77

Note. * $p < .05$; ** $p < .01$; *d* = the effect size.

This study was to examine the correlation between students' learning anxiety and reading rate using Pearson's product-moment correlation coefficient, and data from both group I and II during the silent task was used. According to the results in Table 4, there was a significant, negative correlation between the learning anxiety and reading rate ($r = -.702$, $p < .01$) in group I, and a significant negative correlation between the learning anxiety and reading rate ($r = -.792$, $p < .01$) was also found in group II. Thus, the latter will increase if the former is reduced, and vice versa. This result provides support for Hypothesis 5.

Table 4. Correlation between learning anxiety and reading rate

Variables	Learning anxiety	Reading rate
Group1		
Learning anxiety	1	-.702**
Reading rate	-.702**	1
Group2		
Learning anxiety	1	-.792**
Reading rate	-.792**	1

Note. ** $p < .01$.

As seen in Table 5, the intrinsic load scores were not statistically significant between silent task and music task of both groups, indicating that the different task had the same intrinsic load in this study. This result provides support for Hypothesis 2. However, the extraneous load scores when Mozart was played were significantly higher than those seen for the silent task, and thus the students' had higher extraneous load when listening to this music. This result provides support for Hypothesis 3.

Table 5. *t*-test results for cognitive load

Variables	Silent task			Music task			<i>t</i>	<i>d</i>
	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>		
Intrinsic load								
Group I	34	4.41	1.84	34	3.97	1.38	1.572	0.27
Group II	28	5.43	2.83	28	4.39	1.42	1.850	0.46
Extraneous load								
Group I	34	5.74	2.05	34	7.21	2.04	2.616*	0.71
Group II	28	4.18	1.76	28	6.86	2.38	5.259***	1.28

Note. * $p < .05$; *** $p < .001$; *d* = the effect size.

Reading comprehension

As seen in Table 5, we found the students' reading comprehension in the music task was significantly better than that in the silent task. This shows that reading e-books while listening to Mozart can indeed improve students' reading comprehension, which provides support for Hypothesis 4.

According to PIRLS (Ko, Chan & Chiu, 2013), the reading process can be divided into four phases, (1) focus and retrieve explicitly stated information, (2) make straightforward inferences, (3) interpret and integrate ideas and information, and (4) examine and evaluate content, language, and textual elements (MOE, 2011). Stages 1 and 2 belong to the direct process, while stages 3 and 4 are part of the interpretation process. We thus subdivided the reading comprehension performance of the tested students into the direct and interpretation components for further analysis and comparison. Since the total scores for the direct and interpretation processes of the two articles were different, the scores were standardized to avoid biased results.

In the direct process, we found that the students' performance of two groups in the music task was significantly better than that in the silent task, again indicating that listen to Mozart's K.488 as background music can help student's reading. In contrast, the result for the students' interpretation process performance of two groups in the music task was significantly lower than that in a silent task.

Table 6. *t*-test results for reading comprehension

Reading comprehension	Silent task			Music task			<i>t</i>	<i>d</i>
	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>		
Group I								
Reading comprehension	34	6.94	3.38	34	8.97	3.42	4.343***	0.60
Direct process	34	38.23	19.54	34	55.46	20.74	5.345***	0.86
Interpretation process	34	39.41	24.36	34	30.14	25.95	2.484*	0.37
Group II								
Reading comprehension	28	7.75	2.19	28	10.32	2.44	5.507***	1.10
Direct process	28	42.86	13.95	28	61.48	12.35	5.796***	1.41
Interpretation process	28	43.57	18.10	28	34.29	18.73	3.099**	0.50

Note. * $p < .05$; *** $p < .001$; *d* = the effect size.

Students' feedback from the questionnaires

After the experimental activities, the students were asked the following two questions: First question "Did listening to Mozart help you to relax?" and second question "Did listening to Mozart help you to understand the content of the article?" There were 49 valid responses from all students for the first question, and 52 valid responses for the second. We invited two experts to code the open-ended questions. A Kappa coefficient was used to test the inter-rater reliability of the four sets of data from the coders, and this produced a Kappa coefficient of $K = .795$, $p < .001$. This shows that there was a significant correlation between the assessments made by two coders. Based on the results of experts to code the open-ended questions and descriptive statistics, a summary of the students' answers is shown in Table 6.

Table 7. Summary of the results of the open-ended questionnaires

Type	Number/Total number of responses	Percentage	Reason	Number of students	Percentage
Listening to Mozart can help me relax.	46/49	93%	Music is nice	10	21%
			It makes me happy	9	19%
			I like music	9	19%
			Relaxing	7	15%
			Others	11	23%
Listening to Mozart cannot help me relax.	3/49	6%	Distraction	2	66%
			Feel noisy	1	33%
Listening to Mozart can help me	49/52	94%	It is relaxing	22	44%
			It makes me happy	10	20%

understand the content of the article.			It helps me concentrate	2	4%
			Others	15	30%
Listening to Mozart cannot help me understand the content of the article.	3/52	5%	It has a negative influence on my reading	2	66%
			Feel nervous	1	33%

For the first question “Did listening to Mozart help you to relax?” we found that 46 students (93%) felt that Mozart could help them relax, with the most common reasons being “Music is nice.” For the second question “Did listening to Mozart help you to understand the content of the article?” 49 students (94%) stated that listening to Mozart had a positive impact on their comprehension of the articles.

Discussion

How did Mozart affect learning anxiety, reading rate and reading comprehension?

Excessive anxiety can interfere with students’ cognitive processes, resulting in low performance (Wu & Lai, 2007) and poorer task efficiency (Gifford, & Marston, 1966; Seliger, 1972; Byrne & Eysenck, 1995). In contrast, Job and Dipamo (1991) also found that lower anxiety would result in better performance on a task. Previous studies have found that music can reduce anxiety and improve work performance (Dosseville, Laborde & Scelles, 2012; Lai, Chen, Chen, Chang, Peng & Chang, 2008), and that the slow tunes and classical music in particular have more positive impacts on reading comprehension (Thompson, Schellenberg & Letnic, 2012) and reading performance (Kallinen, 2002).

In this study, Mozart’s piece K.488 was used in e-book reading activities for elementary school students, and the results showed that it lowered their anxiety and raised their reading comprehension performance, which echoes the results of previous works (Dosseville, Laborde & Scelles, 2012; Kallinen, 2002). Sylvester (1995) argued that emotions can affect attention, and attention can affect learning, with negative emotions having negative effects. A number of related studies (Weiss & Cropanzano, 1996; Matuliauskaitė & Žemeckytė, 2011) also claimed that negative emotions can reduce task performance, such as learning achievement, as also found in the current study. Furthermore, we found that the group I’s average reading rate of 291.12 wpm in the music task was significantly higher than that of 282.58 wpm in the silent task, and group II’s average reading rate of 289.93 wpm in the music task was also significantly higher than that of 282.21 wpm in the silent task. Besides, we also found that learning anxiety and reading rate are negatively correlated with each other when students are reading e-books without background music. This finding is in line with previous studies (Gifford, & Marston, 1966; Seliger, 1972). Consequently, our findings are in line with those of related studies (Byrne & Eysenck, 1995; Gifford, & Marston, 1966) which reported that anxiety could adversely affect task efficiency and reading rate.

How did Mozart’s piece K/488 affect direct process and interpretation process performance?

In this study, we found that the direct process performance of students in the music task was better than that of students in the silent reading task. However, the interpretation process performance of students in the music task was lower than that of students in the silent reading task. This was probably because the *capacity* of Taiwanese fifth and sixth grade elementary school students is weaker with regard to the interpretation process than the direct process performance, based on PIRLS (Ko, Chan & Chiu, 2013). Compared with the direct process, the interpretation process is a higher level one that requires “interpretive integration” and “comparative assessment,” which often need more attentional resources (Cheng, 2006). In addition, fifth and sixth grade students are in the “Reading to learn” stage of reading development (Chall, 1983), and this focuses on cultivating the reading strategies that students need in order to acquire knowledge through reading. Although listening to Mozart can help reduce the anxiety of students, it did not seem to have a positive effect on the interpretation process. This can be explained by the Central Capacity Theory of the attention (Kahneman, 1973), which argues that a person’s attentional resources are limited, and multiple tasks will compete for the available attention (Kahneman, 1973). In addition to the above, Sweller et al. (2011) claimed that the cognitive system would fail if intrinsic and extraneous cognitive load exceeded the available resources of working memory. In this study, students’ extraneous load increased when they listened to Mozart music. The results show that the background music produced excess extraneous load in music task. Thus, since the students in the experiment were still in the stage of acquiring reading strategies, their abilities with regard to the higher level interpretation process required more

training. Listening to Mozart might thus have distracted them, leaving too few attentional resources for effective learning to occur.

Conversely, the direct process, which involves tasks such as extracting information, and inference analysis, is a more fundamental learning capability that fifth and sixth grade elementary school students are already familiar with, and thus it requires relatively fewer attention resources. By reducing the anxiety, listening to Mozart may thus be able to promote the students' direct process performance.

Research implications

The main contribution of this study was to discover that listening to Mozart, and especially his piece K.488, can provide fifth and sixth grade elementary school students with effective support, thus reducing their learning anxiety and improving their reading comprehension and direct process performance. However, and in line with the Central Capacity Theory (Kahneman, 1973), we also found that if the students were not familiar with the learning tasks or the strategies used then teachers should not impose too many external factors in the learning activities, such as music, in order to avoid overtaxing the students' attentional resources and extraneous load. Therefore, if teachers want to play Mozart during reading activities, they should consider the difficulty of the learning task they have assigned, so that negative effects can be avoided.

Conclusion

This study has investigated how music, and specifically Mozart, can affect students' learning anxiety, reading rate, cognitive load and reading comprehension when reading e-books, based on 62 senior-grade elementary school students. Based on our findings, we found that Mozart had positive effects on the students' learning anxiety, reading rate, reading comprehension, and the direct process performance in the e-book reading tasks. However, it had a negative impact on the students' interpretation process performance and extraneous load. We inferred that listening music might distract the students as it could take part of resources for attention on the reading task. Therefore, teachers should choose reading tasks with an appropriate difficulty if they wish to play Mozart in class.

It is worth mentioning that the Taiwanese government has initiated a series of pilot projects with regard to adopting e-books in primary and secondary school teaching activities (MOE, 2010). Unlike traditional paper books, e-books can also present multimedia content (Huang & Liang, 2015), and thus they can easily be used to play music, such as Mozart, in order to promote reading effectiveness.

This study is based on data obtained using a subjective learning anxiety scale. In order to explore the related issues more objectively, future research could consider using an electroencephalogram to measure students' learning anxiety.

Acknowledgements

This work was supported by the Ministry of Science and Technology, ROC, under Contracts No. MOST 103-2511-S-006-002-MY3, and MOST 103-2511-S-006-007-MY3.

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