



Effects of Sound on Human's Short-term Memorization

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ABSTRACT: Number of studies reveals that music has an impact on human's brain and mostly helps us to memorize things. These studies only aim for influences of music on long-term memory helping people to memorize and recalling their recollection better. However, no research nor study regarding effects of music on short-term memory has been conducted. In a very short period, whether hearing music might ruin concentration rather than enhancing attentiveness for the efficiency of memorizing or not. If not, which type of music or sound is more capable in increasing the ability to memorize. These questions lead us to develop online tests (<https://lookchinandthegang.wixsite.com/my-site>) by using Digit Span Test as a prototype. The tests were adapted to suit our research questions more completely. Several types of background sound were involved in the tests including metronome (100 BPM), alpha wave which people widely use to play in the background while reading, and silent mode. Test takers are a group of teenagers (between 16 and 25 years old) in Thailand. The results illustrate that the average score and the rate of participants' opinion are nearly identical. Thus, listening to sound while doing the test does not contribute an increase in the efficiency of memorization of participants. Moreover, type of sound is that best to magnify the participants' ability cannot be identified since there are several opinions regarding listening to sound while doing the test either enhancing the efficiency to memorizing (positive effect) or decreasing the ability of participants to recognize (negative effect) or, indeed, has no impact (neutral effect). To conclude, listening to sound could help increase the effectiveness of short-term memory or not is based on preference of the individuals.

KEYWORDS: Digit span test, Listening to music while reading, Short-term memory.

INTRODUCTION

Music has great effects on human activity. In childhood, for instance, most parents generally teach their children how to remember the alphabet by using songs such as ABC songs in which the rhythms are added. So, children can memorize the alphabet constantly and much more easily. When human grow up, it is found that sometimes music influences human's feelings. Some songs create sad feeling, while some results in happiness. Songs are believed to be the memory keeper: they keep some memories or some remarkable events in our life. In 1992, Baumgartner⁷ conducted an experiment having 73 university students as samplings. He questioned them regarding the linking between music and their memory. Surprisingly, only three participants reported that they did not have any music related to their memories, while others had various memories such as trips, journeys and relationships related to a song. This study is therefore, performed in a similar pattern as that of Baumgartner by questioning a group of teenagers in Thailand. Results are quite similar to that mentioned by Baumgartner. Among 83 teenagers (38 males and 45 females), only five of them reported that they do not have any memories related to songs. Others had memories that are related to songs in different levels. Most of them had their memories linked to their relationships such as friends, family, or their loved ones. The second most memories are about important moments of their life, and third-ranked memories are about the time when they traveled somewhere. In addition, several questions were additionally asked if the lyrics of songs are related to their memories. Results showed that almost everyone who answered the survey inquired that there are times the lyrics are related to their memories and there are times that are not, depending on situations.

Many studies revealed that music has impacts on human's memory. Nowadays, many physicians use music to treat Alzheimer patients, music boosts patients' cognitive thinking and their feelings which could reduce risks of brain efficiency loss⁸ Moreover, music also activates some lobes of the brain. So, brain could do the task much more effectively. For instance, a concentration and visual memorization can be improved.

Nowadays, many teenagers listen to music while reading. Result from this study implies that approximately 25% of samplings answered that they always listen to music while reading. Most people agree that music increases concentration, so that we can read longer and can memorize texts much more effectively⁹. Although many studies illustrate that music has impacts on



long-term memory rather than short-term memory, this study is conducted to confirm whether music affects our short-term memory or not. In addition, positivity or negativity of memories is also included in questionnaire.

Digit span test¹ is chosen as a major tool in this study. Three different modes of music are used in three tests. First is alpha wave which is popular among Thai students and currently, it is believed to be useful while reading. Second is the sound of metronome at speed of 100 BPM as it is beneficial for musicians but also creates some stress at the same time. Last, is the silent mode or sound-free to investigate that whether sound affects our short-term memory or rather, it ruins concentration while memorizing in very short time.

THEORIES

Short-term memory is the procedure which occurs after receiving information for a short time in a part of the brain; Hippocampus¹¹, region of the brain that is associated primarily with memory. The hippocampus, which is located in the inner (medial) region of the temporal lobe, forms part of the limbic system, which is particularly important in regulating emotional responses. The hippocampus is thought to be principally involved in storing long-term memories and in making those memories resistant to forgetting, though this is a matter of debate. It is also thought to play an important role in spatial processing and navigation. Some studies suggest that the hippocampus binds items and contexts into unified experiences and stores them. Other studies suggest that the hippocampus is preferentially involved in conscious recollection, or the experience of mental time travel during recall. Still, other studies suggest that the hippocampus is able to support rapid learning by reducing interference among similar memories (for example, where a person parked his or her car today versus yesterday). Some theories of hippocampus function treat the hippocampus as an index (much like an index at the end of a book) that binds together elements of an experience but does not store the experience itself. The latter is assumed to be stored in a distributed fashion throughout the brain, while the hippocampus is assumed to possess an index of that distributed code.

Most of the information kept in short-term memory will be stored for approximately 20 to 30 seconds due to limited capacity. Thus, the information in short-term memory should be repeated otherwise it will disappear. However, if the information is collected for a longer period, this information will turn into long-term memory. Furthermore, the amount of information that humans can store in short-term memory is between five and nine items. So, it can be a single information or a group of memories in short-term memory. According to study of Miller², the ability of humans to memorize can drastically increase, if information is allocated into the groups. Currently, it is found that people can store the information in short-term memory between four and five items in average.

The Digit Span test is one of the most commonly used measures of immediate verbal recall, attentional capacity, and working memory in neuropsychological research and clinical evaluations. This test comprises two modalities, digits forward and digits backward. It has been established that age, education, and culture are important variables that affect performance on this test.

Moreover, Digit span test is a test of working memory or sometimes called short-term memory. The test is performed as assessor reads sets of numbers at the speed of 1 number per 1 second and the test taker must remember and recall the number they heard in forward sequence and then in backward sequence. The number of digits in a set is increased continually until the test taker cannot recall the number they heard completely and correctly, which is the termination of the test. People who are over 18 years old can normally tell 6 digits forward and only 3 digits backward¹.

Metronome³ is the device that has been developed from pendulum movement, swing back and forth. Metronome was first used in 1696 by Etienne Loulie. Nowadays, it is used by musicians to determine the rhythms of instruments in beat per minute (BPM). The speeds are various: the moderate speed is between 24 and 200 BPM.

Alpha waves¹⁰ are one of the brain waves detected by Electroencephalogram (EEG). Alpha waves have a frequency between eight and thirteen hertz and these waves are generally produced from human's brain during relaxing periods. Several researchers found that under this condition where brain produces Alpha waves, the ability to learn and recognize is obviously improved or in other words, to have an efficiency to memorize.



METHODOLOGY

The questionnaire was divided into three major parts including pre-test survey, short term memory tests, and post-test survey. The pre-test survey inquires participants' general background (e.g. gender) and also includes the questions related to the music and their memories that were used in the experiment of Baumgartner¹. The survey also asked about their reading behavior whether they listen to music while reading or not, and which types of music they usually listen to.

Then, the short-term memory tests were conducted by the Digit Span Test¹, which is generally used by physicians. The test is performed as described in theory section. Nevertheless, the test performed in this study is an online test in which a set of numbers will appear on the screen for only 1-5 seconds, depending on the number of digits in the set. The number of digits starts from one digit in the first set and is increased to two digits in the second set and is then continuingly increased to 12 digits in the last set. The test takers must quickly remember numbers when a set of numbers appears and fill what they saw into the blank space provided. Furthermore, some sounds are added during the test to compare which one is greater in affecting short term memory and whether having sounds playing in the background or without is better for effectiveness in short term memorizing. There are three different modes of test which are 1) Test1 Alpha wave sound; 2) Metronome at 100 BPM; and 3) silent mode or sound-free.

Lastly, the post-test survey is given to the test takers to assess their opinions on types of sound that have an impact on their memorizing capability.

RESEARCH QUESTIONS

- 1) How many people who had listened to one song in the past and then return to listen to that song again causing them to recall those feelings which they had felt before while listening to that same song.
- 2) How Listening to music or songs influence the efficiency of short-term memory; increasing or decreasing the efficiency of memorizing or irrelevant. Moreover, if it increases the efficiency of short-term memory, listening to what type of music is the greatest way to magnify the efficiency.

RESULTS AND DISCUSSION

From the participant survey, summary of rate of teenagers who listen to music while reading is shown in Table 1. From the table, the highest frequency is found in rate 5 or the rate at which the most frequent in listening to music while reading. The frequency is about 21 people, accounting for 25% of the whole participants. Meanwhile, only 14 people, accounting for 17.20 % that nearly never listen to music while reading. Others replied that they sometimes listen to music while reading. Thus, since there was no obvious difference found in each frequency, the behavior of listening to music while reading test takers could not be clearly summarized.

Table 1: Number and percentage of test takers regarding participants' frequency of listening to music while reading showed in 1-5 rate (1 means almost never and 5 means really frequently). (n=83)

Rate of listening to music while reading	Frequency	Percentage
1	14	17.2
2	17	20.3
3	18	21.9
4	13	15.6
5	21	25.0
total	83	100.0

Table 2 summarizes frequency of test takes prior to the test regarding opinions about listening to music and their preference on music. From the table, the figure for participants who pointed out that music has no positive effect on their memorization showed the highest rate (39.1%), other 34.4% mentioned that music helps them to remember texts easier but more likely to disturb their



concentration, while those who believed that music could help them in memorization were only 26.6%. More than half of participants prefer to listen slow tempo song and study music that typically found in streaming platforms while reading which both have slow rhythm. Fast tempo songs, on the other hand, showed only 4.7% of preference.

Table 2: Individuals' opinions on listening to music while reading and their preference on types of music that they usually listen to.

Observation before doing the tests	Frequency	Percentage
1) Opinion about listening to music while reading		
Music could help in memorizing	22	26.6
Music could not help in memorizing, rather disturbs concentration	29	34.4
Music does not have any impact on memorizing	32	39.1
Total	83	100
2) Type of music that participants usually listen to		
Slow tempo song	27	32.8
Study music	19	23.4
Do not listen to music while reading	12	14.1
Beat song	9	10.9
Fast tempo song	4	4.7
others	12	14.1
Total	83	100

Table 3 summarizes the average scores of alpha waves (Test 1), metronome (Test 2) and Silent mode (Test 3). According to table, due to the efficiency in memorizing individuals may be differed, scores were separated into 3 ranges which are 0-4, 5-8 and 9-12 points to reduce as much as possible the deviation of average score. The results revealed that in each range of scores, the average scores in all tests were almost the same. When considering total average scores, test 3 was found to be slightly higher than others.

Table 3: The average scores of three different tests which is separated into 3 ranges of scores

Test Number	Range of scores			Total average score
	0-4	5-8	9-12	
Test1 (included alpha wave)	2.38	6.75	10.23	6.45
Test2 (included metronome sound)	2.9	7	10	6.63
Test3 (no sound included)	3	6.94	10.32	6.75

Results from three tests illustrated that the questions which participants frequently missed were the questions no.10,11 and 12 (Q10, Q11 and Q12) that required 10,11 and 12 digits each set of numbers, respectively. Therefore, percentage of error in each question were calculated and compared in Table 4 showed. According to Table 4, in Q10, test 1 which included alpha wave showed the highest level of errors (77.1%), whereas test 2, added metronome sound showed the highest error percentages both in Q11 and 12. In addition, the lowest error percentages in each question were found distinctively in three different tests and when considering an average error percentage in each question, it is clear that the scores were regardless of music added in, rather related significantly to the numbers of digits participants had to remember.



Table 4: Percentage of error in Q10, Q11 and Q12

Test Number	Score		
	10	11	12
Test1 (included alpha wave)	77.11%	77.11%	85.54%
Test2 (included metronome sound)	64.58%	81.25%	89.58%
Test3 (no sound included)	71.05%	78.95%	78.38%
Average error percentage	70.91%	79.10%	84.50%

Table 5 reveals participants’ opinion on the level of music that affects their memorization rate in range 1-5. According to the table, only 4.3% of participants indicated that the level of music does not have an impact on their memorizing ability or has very little impact (rate 1), whereas 29 people, accounting for 34.8%, pointed out that music has moderate effect (rate 2-3) on their memorization. However, 37% of admitted said that music obviously affects (rate 4-5) their memorization showing that, in the opinion of the majority, music really impacts memorization.

Table 5: Participants’ opinion on the level of music affecting their memorization showed in rate 1-5 (1 means very little or has no effect while 5 means has strong effect) and their preference on the type of music that helps them in memorizing the most.

Participants' opinion after the tests	Frequency	Percentage
1) Level of music impact on memorizing 1-5 (Quite little or has no effect - has strong effect)		
1	4	4.3
2	20	23.9
3	29	34.8
4	14	17.4
5	16	19.6
Total	83	100
2) Preference on type of music that is the most helpful in memorizing		
Study music (test1-alpha wave)	24	28.92
Beat (test2-metronome 100 BPM)	21	25.3
No sound included (test3)	38	45.78
Total	83	100

For the types of sound included in the tests which enhanced their memorization efficiency the most in their opinion, the results showed that 21 participants voted for metronome and 24 people voted for alpha waves. The other 38 participants, accounting for 45.78%, chose of having no sound playing in the background (silent mode) helped them the most. Therefore, there was almost no difference in the number of participants who agreed for having sound playing in the background while doing the test to enhance their memorizing efficiency and the number of participants who chose having no sound included in the test better helped them to memorize things more efficiently.



Considering frequencies of participants' behavior of listening to music while reading collected from the survey, frequencies were found almost equal. This is due to the fact that the behavior of listening to music while reading depends on each person's opinion. In addition, the results showed that the majority usually listens to slow-tempo songs or study music provided on YouTube more than other types of music. Furthermore, the survey showed that there are only 22 participants, accounting for 26.6%, who agreed that listening to music while reading helps them to read better. Additionally, some of them indicate that because of music, it helps them to concentrate on reading better, enhancing their memorizing efficiency. However, the other 61 participants feel that listening to music does not have impact on the efficiency of memorizing. Some even feel that it rather distracts their focus. The results led us to develop 3 tests in which no sound was included in test3 while alpha waves and metronome 100 BPM were included in test1 and test 2, respectively. It came out that test3 gained the highest average score of 6.75 out of 12 points. Besides, there were 38 participants, accounting for 45.78%, who said that having no sound played in the background of the test helps enhance their efficiency in short-term memorization the most. Furthermore, taking the test results and participants' opinion after the test into consideration, it can be seen that sound has an effect on answering the test. However, since the outcome frequency of each answer in the survey has very little difference to one another, summary of whether the effect was in a positive or negative way could not be made. Moreover, it can be found that most participants can remember up to 5-8 digits in the test. Increasing to more than 8 digits would lessen their efficiency in memorizing as can be seen from the error percentage of Q10-Q12 which are higher than the others.

CONCLUSION

An average score in each test was nearly identical. Although an average score in test where no sound is included was the highest one, the difference from other two tests are insignificant. Therefore, the scores were regardless of music added in, but it rather related significantly to the numbers of digits that participants had to remember. However, this could not be deduced what types of music performs better in encouraging human's ability in short-term memory.

Regarding participants' individual opinion whether sound affects their short-term memory or not, some did agree with the latter, while others argued with various reasons, both positive and negative, based on their own perspectives likewise whether listening to music while reading contributes to increasing efficiency in memorization or not.

Sound added in the tests did not increase the average score of participants and thus, it did not enhance participant's efficiency in short-term memory. In conclusion, music is not a significant factor that raises a human's ability in short-term memory, and it is rather based on individual preference.

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