



# The Relationship Between Arousal Level of Music and Long-Term Memory

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**Abstract.** The present study has investigated whether a high arousal level of music will enhance long-term memory performance at the same emotional valence. The research utilized a quantitative method, and research data was gathered from 18 high school and college students. Have the participants remember 15 nonsense words, do 30 math calculation questions, then do the recognition test, including half words they saw in the first stage. The results reveal that participants have similar values on the recognition test, whether in the high or low arousal conditions. Thus, the results imply that being in a high-arousal music background does not lead to better performance on long-term memory. Theoretical and practical implications of the results are presented and discussed for future researchers.

**Keywords:** arousal · memory · music · emotion · valence

## 1 Introduction

Music is the greatest human creation and is everywhere in our daily life. We will hear it when we are studying, eating, and driving. Few studies have found that music will enhance cognitive performance, like memory, spatial ability, and learning [1, 2]. One reason to explain the influence of background music on cognitive processes is that music will change the listener's internal mood and level of arousal [3]. Music can evoke intense emotional experiences [4]. When listening to music, subjective responses are evoked along the dimensions of valence and arousal that contribute to emotional well-being [5]. This activation will affect emotional behavior and expression, which occur in the central and peripheral nervous systems associated with emotion and enhance memory [6]. According to emotion arousal theory, the events that arouse emotions will activate hormonal and brain systems which regulate long-term memory storage. The emotional situations will trigger the release of several adrenal stress hormones into the bloodstream, which will have an impact on memory storage and is supported by extensive evidence [7]. The studies by Kleinsmith and her colleagues approved the relationship between the arousal level during the learning phase and recall performance later [8]. A high arousal level during learning will improve long-term recall, and a low arousal level will lead to better short-term recall [8].

Arousal usually refers to the response to music on physiological stimulation or intensity of emotion and will be described as high and low activation [9]. It is essential

to find out how background music affects long-term memory. Long-term memory is an information storage system that enables people to hold, access, and apply the abilities and knowledge gained over a long period of time [10]. Long-term memory is a crucial aspect of cognition. It provides a sense of self, orientates people's thoughts and decisions, and enables us to learn [11]. Therefore, the current study used musical stimuli to modulate arousal levels and observed the impact on long-term memory performance.

## 2 Goal and Hypothesis

In the literature, the effect of music on memory is typically to manipulate mood independently or test mood and arousal in conjunction. Based on the previous study, positive moods will improve a variety of cognitive and problem-solving tasks [12]. The enjoyable stimuli, which trigger positive emotion and a high level of arousal, will lead to modest improvement in various tasks [13]. And have the findings led to the question of whether mood or arousal accounts for the different performances on the test. There are differences between mood and arousal. Mood indicates a positive or negative emotional state; however, arousal focuses more on the level of physiological activation [3]. Thus, the current study tries to explore the effect of different arousal levels (high or low) of music on long-term memory.

*Hypothesis: At the same emotional valence, high compared to low arousing music will enhance long-term memory performance.*

## 3 Method

### 3.1 Participants

There were 18 participants taking part in the experiment, and all participants came from high school and college. They were recruited by the convenience sampling that we find the participants from our friends and peers. 61.11% of the participants were female, 33.33% were male. Their ages ranged from 16 to 25 ( $M = 20.44$ ,  $SD = 2.20$ ). All of the participants are Chinese non-native English speakers.

### 3.2 Materials

**Level of Arousal (IV Manipulation).** In this study, classical genre of music was used to manipulate emotional arousal conditions. "Lionelrichie" was employed as the high-arousal music, and "I'm wishing" was utilized as the low-arousal piece. These music pieces were picked from a prior study in which experimenters selected music without lyrics from various music genres, including jazz, rock, metal, classical, and blues [3]. Every piece was evaluated on arousal and mood. They chose music the participants would most unlikely be familiar with and had high inter-rater agreement for mood and arousal. To eliminate the influence of the mood on the participants, we chose two pieces of music with similar mood ratings but significant differences in arousal ratings.

**Word Recognition (DV Measure).** A list of 30 nonsense words composed of five random letters was applied to measure participants' long-term memory like *wsbyd* and *qahny*. The participants were asked to recognize the words they remembered in the memorizing stage. The recognition test consists of 15 distractors that are not on the list and have never been seen before. A higher score means that the participant has better long-term memory.

**Manipulation Check.** The manipulation check consisted of two questions after participants completed both word recognition tests. The participants were asked to rate the arousal level of the music they listened to during the memorization step. If participants thought music was not arousal at all, they chose 1. If they believed the music was extremely arousal, they chose 7. This question helps determine whether the participants have different arousal levels in the two experimental conditions.

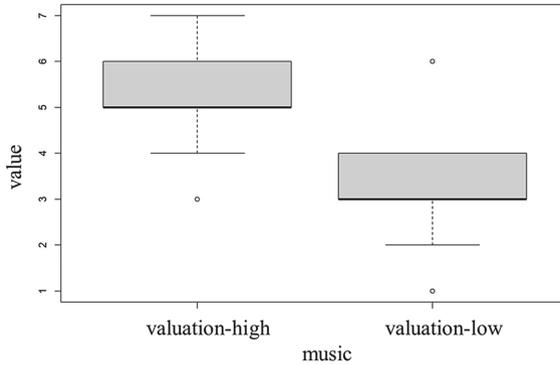
### 3.3 Procedure

Participants were assigned randomly and evenly into two groups. One had high arousal condition first and a low arousal condition later. Another group had a low arousal condition first. All participants were required to answer demographic questions first, including age, gender, and ethnicity. Next, participants were asked to remember 15 nonsense words composed of five random letters in a quiet environment for two minutes. Afterward, they needed to do 30 double-digit addition and subtraction questions in two minutes. Next, they will do the word recognition test to identify the words they remembered before. There are 15 distractors on the recognition list. The same people repeated the same steps twice but in different orders of the arousal conditions. Half of the participants will listen to the high-arousal music first, and the rest will listen to the low-arousal music first. Then participants answered the manipulation check to rate each music piece's arousal levels. Finally, we expressed thanks to the participants and debriefed them after the survey.

## 4 Results

### 4.1 Manipulation Check

On average, when participants listened to music of high arousal level ( $M = 5.33$ ,  $SD = 0.97$ ) perceived the music as more psychological arousal than the music of low arousal level ( $M = 3.33$ ,  $SD = 1.188$ ) (Fig. 1). A paired sample t-test was conducted at an alpha level of .05 to determine if this difference between high and low arousal level conditions was statistically significant. As shown in Table 1, the results indicate that the difference was statistically significant,  $t(17) = -7.823$ ,  $p = 0.001$ , which proves that the manipulation was successful.



**Fig. 1.** Boxplot of manipulation check. (Self-painted)

### 4.2 Recognition Test

As shown in Table 1, the score of participants got in the high arousal level condition ( $M = 0.722, SD = 0.168$ ), on average, given similar accuracy as in the low arousal condition ( $M = 0.681, SD = 0.205$ ) (Fig. 2). According to the result of the current study, this was opposite of what we predicted. A paired sample t-test was conducted at an alpha level of .05 to determine if this difference between the high arousal level condition and the low arousal level condition was statistically significant. As shown in Table 1, the results indicate that the difference was not statistically significant,  $t(17) = 0.967, p = 0.347$ , which does not support the current hypothesis: at the same emotional valence, high compared to low arousing music will enhance long-term memory performance.

**Table 1.** Analysis of the Arousal Level of music on long-term memory

	High-Arousal		Low- Arousal		<i>t</i>	<i>p</i>
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>		
Accuracy	0.72	0.17	0.68	0.21	.967	.347
Level of Arousal	5.33	0.97	3.33	1.19	-7.823	.001

Note: N = 17

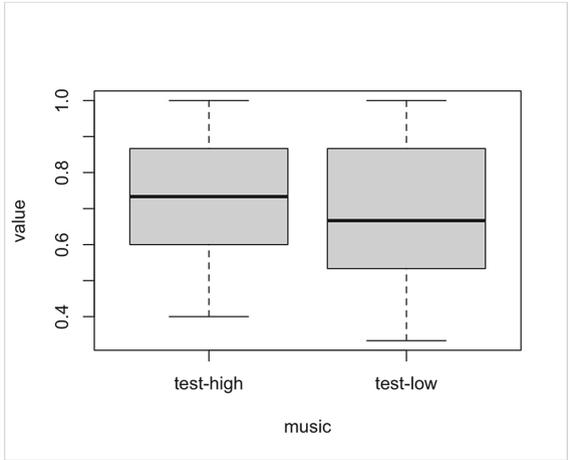


Fig. 2. Boxplot of accuracy of recognition test (Self-painted)

## 5 Conclusion

The present study aimed to explore the impact of the level of arousal on long-term memory, suggesting that high compared to low arousal levels will enhance long-term memory performance. The results of this study were unsuccessful in supporting this hypothesis. However, that does not mean that there is no relationship between arousal level and long-term memory. Overall, the current study reveals that high school and college students are able to perceive and recognize the different levels of arousal for music. Still, memorizing with a high arousal level of music does not have a better performance on long-term memory than in low arousal level music.

### 5.1 Limitation

The design of the present study has a few limitations, so the research is unable to reach a more generalized conclusion. This is because we used convenience sampling, which means using people we can find, so we recruited participants from our friends. It may cause bias that participants may have similar intelligence and memory ability levels. The selected population only covered high school and college students, and if the study were conducted by employing students who did not enroll in higher education, the results might differ. Students are always in the studying environment and mode, which will be more familiar and adapt to the memory test. The gender distribution is also uneven, with 61.11% of the participants being female and a smaller percentage being male. According to the affect intensity hypothesis, females will have better memory performance because they perceive more intensive reactions to emotional experiences than males, which will help enhance the encoding of the memory trace [14]. In addition, the sample size of this study was small. Therefore it is not representative of the results from a large portion of the population. Besides that, the memory tests we used were all nonsense words uncommon in daily life. Thus, when participants were asked to memorize the test, they

would feel unfamiliar with the list. According to the practice effect, they will improve the test performance because of repeated exposure to the material [15].

## 5.2 Future Direction

The results of the current study imply that arousal level does not affect long-term memory. Past literature has proven and demonstrated that the combination of mood and arousal has an important influence on the modulation of memory [1]. The study found that the positive mood and high arousal condition and negative mood and low arousal condition will improve memory sensitivity [1]. The prior works of literature about how emotion impacts memory have the limitation that did not distinguish the effect of mood and arousal and combine them into one measure of “positive” and “negative” arousal [1]. The current study results indicate no statistically significant difference in the accuracy between the high arousal level of music and the low arousal level of music while participants were memorizing. However, in the era of music all over the place and involved in our daily life, it is very worth investigating the use of music on memory modulation. More study needs to study why arousal involved with eliciting mood will enhance memory performance.

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