A study of Mozart effect in Attentional blink

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Abstract

In this paper, we investigated the existence of the temporal component of Mozart effect, analyzed the influence of arousal or mood changing to attentional blink when listening to Mozart Sonata (K.448 D Major). We manipulated the tempo and the mode of Mozart Sonata to check if these two factors of music could affect participant's temporal attention in two experiments. According to the experiment results, the temporal component of Mozart effect does not general exist. Mozart Sonata might possibly induce listener's arousal or mood shifting, but could not induce any temporal attention improvement significantly.

Key Words: Mozart effect, Attentional blink, arousal, mood

1. Introduction

A set of research results indicate that listening to Mozart's music may induce a short-term improvement on the performance of certain kinds of mental tasks. Mozart effect was reported firstly by Rauscher, Shaw, and Ky[1] who investigated the effect of listening to music by Mozart on spatial reasoning. In their study, the subjects got 8 to 9 points improvement in spatial-temporal tasks after they listened to 10 min Mozart's Sonata for Two Pianos in D Major, K.448). However, among the large number of attempts trying to replicate the findings, some have, indeed, reproduced the findings, while others failed to show a significant effect of listening to Mozart's music. Nonetheless, despite critical discussions, the more widely accepted account to explain those failures of replication is that Mozart's music may induce the change of listener's arousal or mood rather than their spatial-reasoning ability, and that change may influence the spatial reasoning processing. It is well know that arousal and mood influence cognition. According to the arousal-mood hypothesis, listening to music affects arousal and mood, which then influence performance on various cognitive skills or mental function (Gabrielsson, 2001; Krumhansl, 1997; Peretz, 2001a; Schmidt & Trainor, 2001; Sloboda & Juslin, 2001; Thayer & Levenson, 1983)[2-7]. Several studies supported the

similar results that participants who listened to fast major music had better performance in tests than those who listened to slow minor music. In one study, researchers examined the effects of Musical Tempo and Mode on arousal, mood, and spatial abilities. In their experiments, participants were asked to do the paper-folding-and-cutting (PF&C) task while listening to one of four versions of the Mozart sonata (K.448) by adjusting specific properties of the music: tempo (fast or slow) and mode (major and minor). According to their results, exposure to fast-major K.448 helped participants improving performance significantly (Gabriela husain, 2002).

Further more, another report claimed their finding of the existence of a temporal component to the 'Mozart effect' in non-spatial visual Attentional Blink task experiments (Cristy Ho, 2007)[8]. They compared participants' temporal attention in AB task under three conditions (Mozart sonata played normally, in reverse and in silence). They put forward the result that 'Mozart effect' influenced temporal attention and that made participants made better performance when they listened to Mozart sonata played normally. It was discussed that the temporal influence may depend on the changing of the arousal or mood induced by Mozart's music. It is an exciting finding if the temporal component does exist in Mozart effect. To assess the validity and determine the explanation of Mozart effect's temporal influence, more evidence and analysis are needed. Attentional blink will be introduced later at 'Prior knowledge'.

The purpose of present study is to validate whether Mozart effect can influence temporal attention in a general way, in another word, if Mozart effect temporal influence is a robust phenomenon. Following this, we also further investigated the reliable explanation of the Mozart effect temporal influence if it exactly exists. Toward this end, we also used attentional blink experiment, as attentional blink can be viewed as a method to access the limits of human's ability to consciously perceive stimuli distributed across time.

In experiment 1, we manipulated the tempo of the background music in the experiment as: in silence (baseline), Mozart Sonata (K.448 D Major) played normally and Mozart Sonata (K.448 D Major) played in fast speed. We predicted that, if Mozart effect temporal influence exists, participants should do better performance in attentional blink task when they listen to Mozart Sonata played in normal than in silence. As enjoyment ratings are much higher if the tempo is fast when listening to major music, if the Mozart effect temporal influence depends on the arousal or enjoyment inducing, participants should do the best performance in the attentional blink task under the Mozart Sonata (K.448 D Major) fast condition. We will briefly address those three experiment conditions as: silence, Mozart normal and Mozart fast

condition in the following.

In experiment 2, we manipulated the mode of the background music in the experiment as: in silence (baseline), Mozart Sonata (K.448 D Major) played normal speed and Mozart Sonata (K.448 D Minor) played in normal peed. If Mozart effect influences temporal attention by adjusting listener's mode, the performance of participants in attentional blink task should be significant different under three audio background conditions. According to the conclusions in previous studies, major music could induce positive mode and minor music could induce negative mode, it can be predicted that participants should conduct the attentional blink task best under Mozart Major condition, and worst under Mozart Minor condition. We will briefly address those three experiment conditions as: silence, Mozart Major and Mozart Minor condition in the following.

2. Prior knowledge

Visual attention plays a vital role in visual cognition. The mechanism of visual attention has been studied over 50 years as one of the major goals of both cognitive science and neuroscience (Miler, 2003)[9]. In the last 15 years, the intense interest among researchers has shifted from the mechanisms and processes involved in deploying across space dimension to time dimension (Paul E, 2009)[10-12]. Attentional blink is a robust phenomenon which reflects human attention constraint. In a typical attentional blink experiment, participants are required to observe a rapid stream of visually presented items (RSVP). There are two targets (T1 and T2) embedded in the stream of nontargets (i.e., distracters). Participants are instructed to report the two targets after the stimulus stream ended. The AB is defined as having occurred when T1 is reported correctly but report of T2 is inaccurate at short T1-T2 lags, typically between 100 to 500 ms, but recovers to the baseline level of accuracy at longer intervals.

Theoretical accounts of the Attentional blink indicate that attentional demands of T1 for selection, prevents attentional resource from being applied to T2 and transiently impairs the redeployment of these resources to subsequent targets at short T1-T2 lags. The research of attentional blink helps us to investigate human reaction in some real-life situations in which multiple events may rapidly succeed each other (e.g., in traffic).

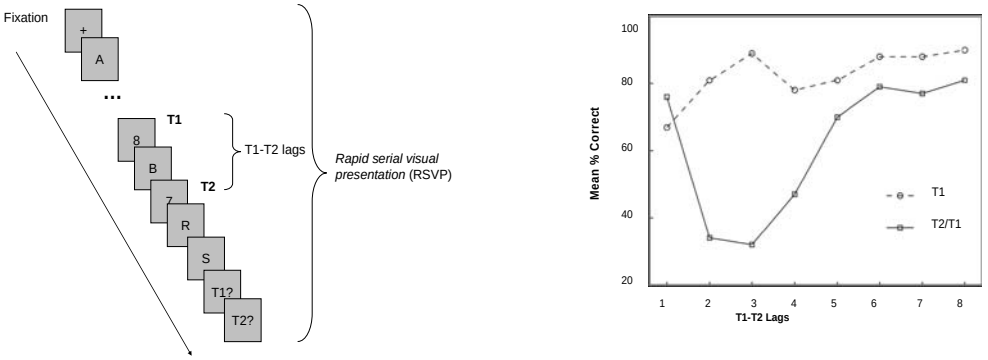

Fig. 1. Standard attentional blink task and typical attentional blink phenomenon.

3. Experiment 1

Experiment 1 aimed at testing whether the Mozart effect affects attention in temporal dimension by musical tempo. We manipulated musical tempo of Mozart Sonata and controlled the mode of the music[13], checking if the performances of the participants change under the different background conditions: silence, Mozart normal and Mozart fast.

3.1 Methods

3.1.1 Subjects

Twenty six participants between 21 and 27 years old (Mean = 23.9) were recruited from the local university of applied sciences, twelve were female, and all right-handed. Subjects were paid for participation and oral consent was obtained prior to start of the experiment. All participants had normal or corrected-to-normal visual acuity and normal hearing by self-report. The experiments lasted for approximately 40 min. All participants had no specific music or instruments learning experience.

3.1.2 Apparatus and materials

The software program E-Prime (Psychology Software Tools, Inc., Pittsburgh, PA) installed on a desktop computer with CRT monitor (screen refresh rate of 85Hz) was used to display the visual stimuli and record the data. The distance between participant and monitor screen was approximately 65 cm. Participant sat directly in front of the monitor in a quiet experimental room and had a comfortable sight view of the screen. Visual stimuli consisted of letters from the alphabet omitting letters I, O, Q, and S and digits 2 to 9, was displayed in black in the centre of a gray background with Courier New font, size 22. Auditory stimulus was Mozart Sonata for Two Pianos in D Major, K.448 played in normal speed (tempo of 65 bpm) or fast speed (tempo of 120 bpm), and was played over headphone. In the silent condition, no music was played over the headphone.

3.1.3 Design & Procedure

The present study employed a dual target task in four blocks. The first block was practice block with 10 trials under silence condition and not included in statistic, the left three blocks were statistic blocks with 100 trials each and under silence, Mozart normal, Mozart fast condition respectively. Each trial began with the presentation of a fixation cross '+' for 1000ms followed by 13 – 21 distracter letters (presented randomly without replacement from 22 letters except letter 'X'), one of which was replace by a digit (first target T1, presented randomly without replacement from 8 digits). The letters and digit were presented for 65ms each, followed by a 15 ms blank interval. The second target T2 in each trial was letter 'X', presented on 80% of the trials with 3-6 positions randomly from the end of the stimulus steam. The first target digit (T1) was presented randomly 1, 3, 5, 8 stream positions (80ms, 240ms, 400ms, 640ms) before T2. After the presentation of RSVP in each trial, two questions about T1 and T2 ('Was the digit even number or odd number?', 'Was there a letter 'X' in the stream?') was presented orderly. The participants were instructed to answer these two questions by pressing the specific letter key on the keyboard of the computer at the end of each trial. The second question was presented 250ms after the response to the first question. The next trial began 500ms after the participants had responded to the second question.

Participants were asked to concentrate their mind to the RSVP on the screen and answer the two questions as accurately as possible. All responds of the participants were recorded. The experiment was within-participants manipulation with balanced block design of conditions (i.e. Mozart Normal-Silence-Mozart Fast, Silence-Mozart Fast-Mozart Normal, and Mozart Fast-Mozart Normal-Silence).

3.2 Results

The data of all twenty six participants were taken into statistics. We concerned the second target T2 report accuracy at the trials that the first target was reported correctly. Fig.3. shows Mean T2 detection accuracy while T1 detect correctly as a function of Condition and Lags. Lag 0 represents the trails which contained no letter 'x', Lag1, 3, 5, 8 represent T1-T2 lags. As we can see in the Fig. 3., at Lag0, 5, 8 the accuracy of T2 is almost the same, at lag1 and lag3, the accuracy of T2 is slightly better under the Mozart Normal condition than under the silence condition. Nevertheless, under Mozart fast condition, the accuracy of T2 is worse than under the Mozart Normal condition and almost the same as under the silence condition. This is not consistent with previous hypothesis. This result indicates that even if any Mozart effect influence exists, it is not induced by the change of arousal and enjoyment.

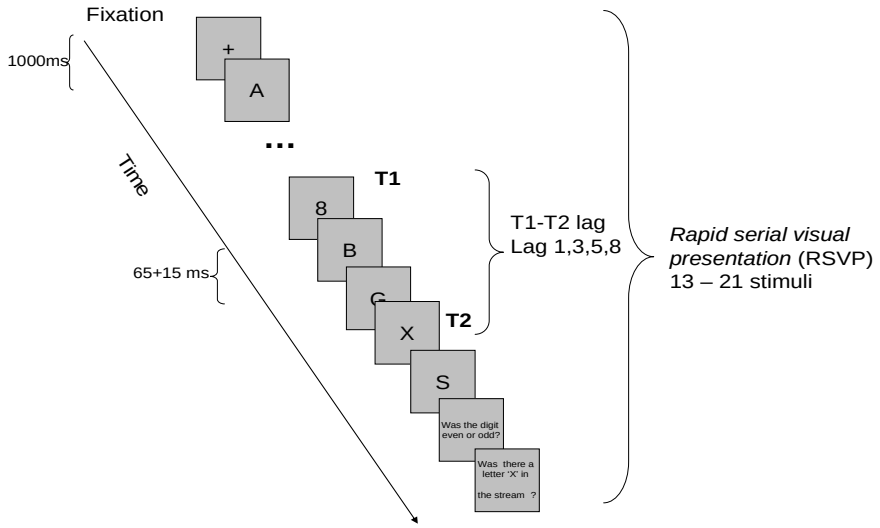

Fig.2. Sequence of screen presentation of a typical trial

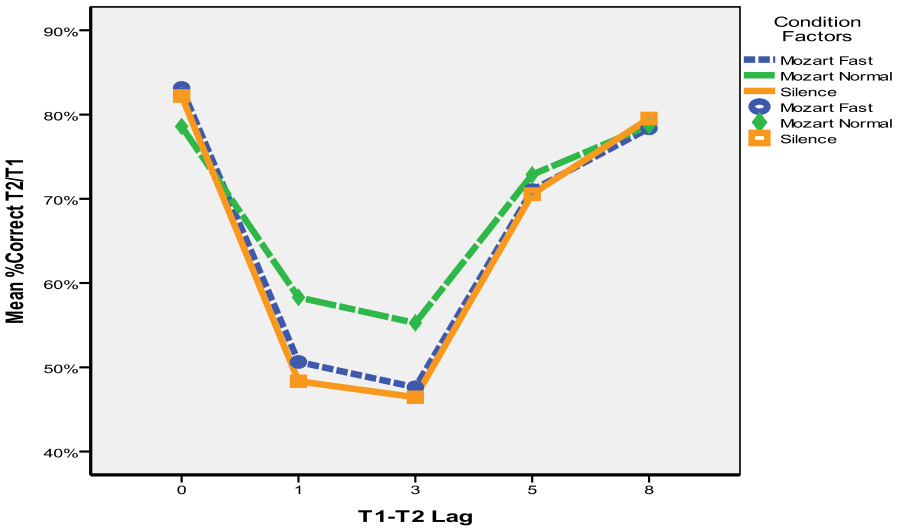

Fig.3. Mean T2 detection accuracy while T1 detect correctly as a function of Condition and Lags.

To make clear if changes of the accuracy of T2 among three experiment conditions are significant, we performed the two-way analyses of variance (ANOVAs) on the accuracy data for T2 with the within-participants factors of Condition(Mozart normal, Mozart fast, or silence) and T1-T2 Lags(0,1,3,5,8). According to the results of statistics in SPSS, there are no main effect of condition, $F(2, 50) = 1.045$, $p = 0.353 > .05$, nor any interaction between condition and lag, $F(8, 200) = 0.731$, $p = 0.664 > .05$. The main effect of lag is significant, $F(4, 100) = 45.089$, $p = .000 < .001$. Subsequent pair-wise comparisons reveal significant differences all 4 lags (omitting lag0, Lag0 was not related to attentional blink phenomena.),

$p < .05$, except the differences between lag1 and lag3 ($p = 0.395 > .05$).

3.3 Discussion

In experiment 1, we conducted the attentional blink experiments under three conditions (Mozart normal, Mozart fast and silence). The results of the experiments reveal that though it seems there is a slight trend of accuracy improvement on detecting the second target T2 at lag 1 and lag 3 under Mozart normal condition than silence condition, but there is no significant difference between these two conditions. In another words, we do not observe significant Mozart effect temporal component in experiment 1.

In the report (Cristy Ho 2007)[8] which claimed the significant temporal influence of Mozart Sonata, the ANOVAs analyses result of the difference between Mozart Sonata and silence was little smaller than significance level, and was little bigger than significance level while excluding the non-blink participants. One explanation for this inconsistence could be that the temporal influence over attention of Mozart effect may not exist or not strong and in general. Even if this influence does exist, the factor induced it could not be the Mozart effect's inducing the change of arousal, since in experiment 1, the detection accuracy on T2 under the Mozart fast condition is almost the same as under the silence condition, and worse than under the Mozart normal condition which expected to be better according to the arousal theory.

Though the results of experiment 1 show that the tempo of Mozart Sonata does not affect the performance in attentional blink experiment, it is still unclear that whether the mode of Mozart Sonata affects the temporal attention. In experiment 2, we manipulated the mode of the Mozart Sonata to check the effect of the mode change to the performance in attentional blink experiment.

4. Experiment 2

Experiment 2 aimed at testing whether the Mozart effect affects attention in temporal dimension by musical mode[13]. The method of Experiment 2 was the same as of Experiment 1 except the background music conditions. We manipulated musical mode of Mozart Sonata and controlled the tempo of the music, checking if the performances of the participants change under the different background conditions: silence, Mozart Major and Mozart Minor.

Subjects of experiment 2 were different from subjects of experiment 1. Twenty nine participants between 21 and 24 years old (Mean = 22.2) were recruited from the local university of applied sciences, thirteen were female, and all right-handed.

4.1 Results

The data of all twenty nine participants were taken into statistics. Fig.4. shows Mean T2 detection accuracy while T1 detect correctly as a function of Condition and Lags. Lag 0 represents the trails which contained no letter ‘x’, Lag1, 3, 5, 8 represent T1-T2 lags. As we can see in the Fig. 4., this time, the performance of T2 is worse under the Mozart Major condition and Mozart Minor condition than under the silence condition. Again, the results of this experiment do not support the hypothesis that listening to Mozart Sonata could improve temporal attention.

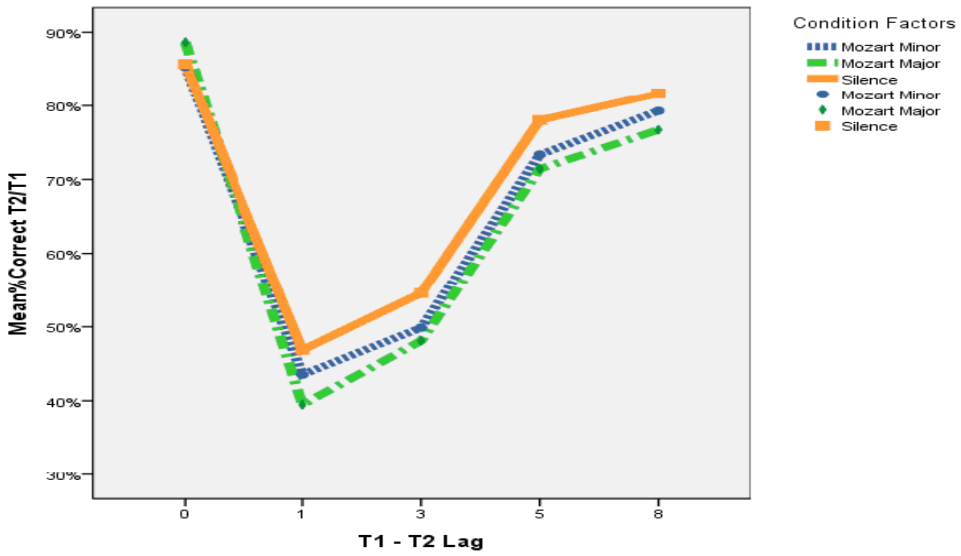

Fig.4. Mean T2 detection accuracy while T1 detect correctly as a function of Condition and Lags.

We performed the two-way analyses of variance (ANOVAs) on the accuracy data for T2 with the within-participants factors of Condition (Mozart normal, Mozart fast, or silence) and T1-T2 Lags (0, 1, 3, 5, and 8) to check the changes of the accuracy of T2 among three experiment conditions. According to the results of statistics in SPSS, there are no main effect of condition, $F(2, 56) = 1.822$, $p = 0.163 > .05$, nor any interaction between condition and lag, $F(8, 224) = 0.339$, $p = 095 > .05$. The main effect of lag is significant, $F(4, 112) = 73.183$, $p = .000 < .001$. Subsequent pair-wise comparisons reveal significant differences all 4 lags (omitting lag0, Lag0 is not related to attentional blink phenomena.), $p < .05$, except the differences between lag5 and lag8 ($p = 0.112 > .05$).

4.2 Discussion

We conducted experiment 2 under three conditions (Mozart Major, Mozart Minor and

silence). The results of the experiment 2 reveal that the performances of detecting the second target T2 slightly reduce under Mozart Major condition and Mozart Minor than under silence condition, however, there is no significant difference between these three conditions. We do not observe significant Mozart effect temporal component in the experiment 2, either.

It is not only validated in laboratory but also experienced in real life that Music including Mozart Sonata does change listener's mood (Gabriala H, 2002)[14].It might bring a change of the detection accuracy on T2 if the participants' arousal or mood is shifted, which is supported by the resource theory of attentional blink. Why did not it appear in present study? The reason might be that the changing mood given by music often does not occur immediately (cf. Panksepp & Bernatzky, 2002)[15]. In experiment 2, the performances on T2 under Mozart Major and Mozart Minor are even worse than under silence condition. It can be explained that the background music might attract participant's attention to listen and that distracted their temporal attention before the music changing the listener's mood[16].

5. General Discussion

Two within-participants experiments with balanced block design of conditions were conducted in present study. To investigate Mozart effect on temporal attention, Mozart Sonata was used as background music condition comparing to silence baseline condition while attentional blink task was conducted. The tempo and mode of Mozart Sonata were manipulated to test which factor of the music contributed to Mozart effect on attentional blink task performance. The results of the experiment do not support the existence of temporal components of Mozart effect. The changes of the tempo and mode do not significantly influence the performance in attentional blink task.

In contrast to findings of Olivers and Nieuwenhuis's (2005)[17], they reported the improvement of the T2 accuracy under the music condition to silence condition also. However, the music they used in the experiment was a tune with continuous beats which had not the same musical meaning as music works like Mozart Sonata. It can be explained that rhythm beat or just sound could induce arousal change more easily, and could attractive human attention so that becoming an irrelative task to the participant. Those activities cause the redeployment of the attention resource of the participant applied to the first target T1, and eventually improve the detection of the second target T2[18-20].

Another possible explanation of the result in present study is culture gap. All the participants were Chinese with no special music education. They self reported that they seldom listened to classical music. All of them never heard of even Mozart Sonata's name.

Their cognitive activity of listening Mozart Sonata might be different from those who are familiar with classical music or grown up in western culture environment.

We can further investigate the existence of temporal component of Mozart effect by EEG or FMRI in the future. We should observe the hemi spatial difference which reflects music effect[19, 21] if Mozart effect does influence temporal attention.

6. Conclusion

The present study investigated Mozart effect on temporal attention using Mozart Sonata as background music. The results of the experiments reveal that the temporal attention influence of Mozart effect is not general exist. Though, Mozart Sonata might change listeners' arousal or mood in many researches, it fails to induce any temporal influence in present experiment. It needs to do further investigation to examine whether Mozart Sonata has post effect on attentional blink.

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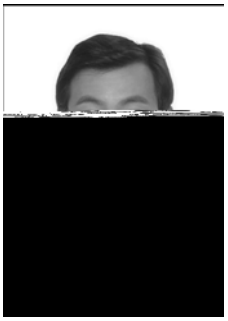

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