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Contribution of Arousal and Mood States to Mozart Listening:

Audiovisual Integration Study

L'ÉCOUTE DE MOZART PEUT AMÉLIORER L'EXCITATION ET LES ÉTATS D'HUMEUR:

UNE ÉTUDE D'INTÉGRATION AUDIOVISUELLE

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Abstract: Several scientific evidences confirm that arousal and mood influence performance on a variety of cognitive tasks. We examined whether the Mozart effect is a consequence of between-condition differences in arousal and mood after simultaneously music and visual graphic presentation. Follow-up analyses were conducted separately for each musical excerpt, visual graphic piece, and simultaneously music and visual graphic presentation. The three posttest measures of arousal and mood were examined separately with mixed-design ANOVAs that had one within-subjects variable and one between-subjects variable. We found that effects of music attributed to differences in arousal and mood, as well as enjoyment. Participants who listened to Mozart scored significantly higher on positive mood and arousal and significantly lower on negative mood compared with their counterparts who listened to Albinoni. Enjoyable stimuli statistically induced positive affect and heightened levels of arousal, which lead to modest improvements in performance on visual graphic perception. Listeners' use of music shows as an agent of emotional change. Our results support previous studies suggesting that the short-term effects of listening to Mozart on spatial ability are an artifact of arousal and mood. The present investigation is the first to examine directly the contribution of arousal and mood to the Mozart listening compared to seeing visual graphic condition. Changes in mood may be induced by giving participants a visual graphic, and changes in arousal occur in response to environmental events.
Keywords: Music; Arousal and Mood; Audiovisual perception; Mozart; Albioni

Résumé: Plusieurs évidences scientifiques confirment que l'excitation et l'humeur influencent la performance dans une variété de tâches cognitives. Nous avons examiné si l'effet Mozart est une conséquence de différences entre les conditions de

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l'éveil et de l'humeur après une présentation simultanée de la musique avec des visuels graphiques. Des analyses suivies ont été réalisées séparément pour chaque extrait musical, chaque morceau visuel graphique, et chaque présentation simultanée de la musique avec des visuels graphiques. Les trois mesures post-test de l'exitation et de l'humeur ont été examinés séparément avec le design mixte d'ANOVA qui avait une variable d'intra-sujets et une variable inter-sujets. Nous avons constaté que les effets de la musique attribuaient à des différences dans l'excitation et l'humeur, ainsi que la jouissance. Les participants qui écoutaient Mozart avaient eu des notes plus élevées dans l'humeur positive et l'excitation et des notes plus faibles sur l'humeur négative par rapport à leurs homologues qui ont écouté Albinoni. Le stimulus agréable induit statistiquement un affect positif et augemente des niveaux d'excitation, qui conduisent à des améliorations modestes dans la performance sur la perception visuelle graphique. L'utilisation de musique se montre en tant qu'un agent de changement affectif. Nos résultats confirment des études antérieures suggérant que les effets à court terme de l'écoute de Mozart sur la capacité spatiale sont un artefact de l'excitation et de l'humeur. La présente enquête est la première à examiner directement la contribution de l'excitation et de l'humeur à l'écoute de Mozart, comparée à la condition de visualisation graphique. Changements d'humeur peuvent être induits en donnant aux participants une image visuelle, et des changements dans l'excitation se produit en réponse aux événements environnementaux.

Mots-clés: musique; exitation et humeur; perception audiovisuelle; Mozart; Albioni

1. INTRODUCTION

It is well-known that music and visual graphic differ in the way they exploit spectral and temporal cues. Especially, the auditory signals can be differentiated by a variety of factors, including spectral and temporal information. Theoretically, the human central auditory system has a remarkable ability to establish memory traces for invariant features in the acoustic environment such as music or sounds, in order to correct the interpretation of natural acoustic sound heard. Even when no conscious attention is paid to the surrounding sound, changes in their regularity can cause the listener to redirect his or her attention toward the sounds (Tervaniemi *et al.,* 2001).

Previous study reported that college students perform better on standardized tests of spatial abilities after listening to 10 min of a Mozart sonata than after listening to relaxation instructions or sitting in silence (Rauscher *et al.,* 1993). Despite the short-term nature of the so called Mozart effect, the results received widespread attention in the popular and scientific media. Even though several studies (Rauscher *et al.,* 1995; Chabris, 1999; Hetland, 2000; Steele *et al.,* 1999; Thompson *et al.,* 2001) failed to replicate the effect raise doubts about its reliability, Chabris's study using a meta-analysis conceded that there may be a small intermittent effect, but that it probably arises from "enjoyment arousal or mood" induced by music (Chabris, 1999; Nantais and Schellenberg, 1999; Thompson *et al.,* 2001). It has been proposed that the Mozart effect may have little to do with Mozart in particular or with music in general. It rather represents an example of enhanced performance caused by manipulation of arousal or mood instead (Thompson *et al.,* 2001). This hypothesis was supported by several studies indicating that very high or low levels of anxiety or arousal inhibit performance on cognitive tasks, whereas moderate levels facilitate performance (see in Yerkes and Dodson, 1908; Berlyne, 1967; Solomon & Corbit, 1974; Sarason, 1980). Additionally, Thompson *et al.,* (2001) summarized that negative moods and boredom can produce deficits in performance and learning (Kovacs and Beck, 1977; O'Hanlon, 1981; Koester and Farley, 1982; see in Thompson *et al.,* 2001), whereas positive moods can lead to improved performance on various cognitive and problem-solving tasks (Ashby *et al.,* 1999; Isen, 1999; see in Thompson *et al.,* 2001).

The present study focuses on "How is the tonal (Thai) speaker brain's music and visual graphic processing represented in arousal and mood states? The aim of the present study thus was to study the tonal (Thai) speaker brain's audiovisual integration mechanisms for visual graphic processing associated with music perception. This study explored the contribution of arousal and mood to the Mozart effect relating to the visual graphic processing and perception. The effects of two musical pieces: a Mozart sonata and Albinoni will be investigated in relation to its applicable visual graphic formats. The Mozart sonata was expected to induce heightened arousal and positive mood whereas an adagio by Albinoni was expected to induce low arousal and sad mood. The arousal and mood were then evaluated after exposure to each piece. Participants also rated their enjoyment of each piece. Additionally, the goal of the study was designed to re-examine the effects of attention in audio, visual and audio-visual dimensions. The effects of music would be expected to attribute differences in arousal and mood, as well as enjoyment.

2. METHOD

2.1 Participants

The participants were 24 Thai-speaking right-handed undergraduate students (age range: 18 to 32 years; handedness assessed according to Oldfield (1971), with normal hearing and no known neurological disorders volunteered for participation. The mean (±sd) age was 25.73 (±3.1) years. All participants had no formal music lessons. The written consent from each subject was obtained prior to data acquisition.

2.2 Stimuli and Procedures

The musical excerpts consisted of 10 min from Mozart's (1985, track 1) Sonata for Two Pianos in D Major, K. 448, or 10 min from Albinoni's (1981, track 1) Adagio in G Minor for Organ and Strings. The excerpts were digitally rerecorded from compact discs onto the hard disc of a computer without loss of sound quality. For the Mozart sonata, we recorded the entire first movement and replayed it until 10 min were accumulated. The sound file for the Albinoni adagio was created in the same way; participants heard the entire piece and a repetition of the early portion. The audio-visual experiment included four stimuli: congruent [Mozart] (audio [Mozart] + visual graphic [Mozart]), congruent [Albinoni] (audio [Albinoni] + visual graphic [Albinoni]), incongruent [Mozart] (audio [Mozart] + visual graphic [Albinoni]) and incongruent [Albinoni] (audio [Albinoni] + visual graphic [Mozart]). The auditory and visual experiments included only the audio and the visual parts of these stimuli, respectively (see Fig. 1). The stimulus sequences presentation was controlled by SuperLab software V. 3.0 (Cedrus Cooperation, San Pedro, CA, USA). While visual stimuli were presented on the computer screen, audio stimuli were delivered binaurally to the participants through plastic tubes and earpieces. Sound density was adjusted to be 85 dB above the participant's hearing threshold.

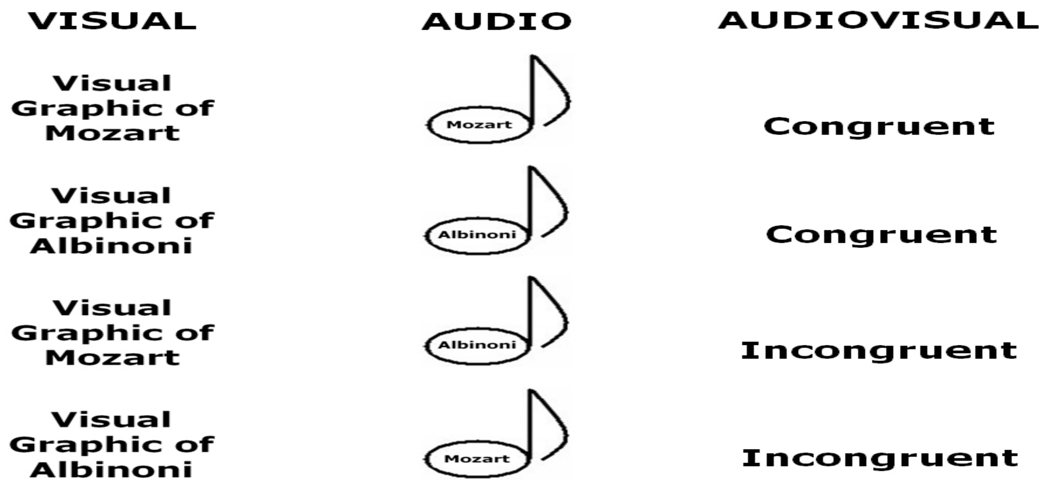

Figure 1: Illustration of the experimental conditions

The outcome measure in this study adopted from previous study (Thompson *et al.*, 2001). It was supplementary measures including the Profile of Mood States (POMS)—Short Form (McNair *et al.*, 1992; see Thompson *et al.*, 2001), which assessed arousal level and mood as determined by scores on the Vigor-Activity and Depression-Dejection subscales, respectively. The POMS consists of 30 adjectives describing feelings and mood. Adjectives in the Vigor-Activity subscale (*lively*, *active*, *energetic*, *full of pep*, and *vigorous*) describe positive arousal; those in the Depression-Dejection subscale (*sad*, *unworthy*, *discouraged*, *lonely*, and *gloomy*) describe negative affect. This study refers to these scales as *POMS arousal* and *POMS mood*, respectively according to Thompson's study (Thompson *et al.*, 2001). In addition, all participants used a 5-point scale (anchored by *not at all* and *extremely*) to indicate the degree to which each adjective described their mood. Participants also provided a global rating of mood and arousal on a scale from 1 (*sad*) to 7 (*happy*); Thompson *et al.* (2001) refer to this as the *subjective mood-arousal* rating. Participants were told that any high-energy mood should be placed at the high end of the scale and that any low energy mood should be placed at the low end of the scale. Therefore, feelings of meditation, contemplation, or melancholy would be assigned low ratings. In effect, the subjective mood-arousal rating combined mood and arousal into a single measure, providing a global but subjective counterpart to the POMS measures. Finally, participants used a 7-point scale to rate how much they enjoyed the music (Thompson *et al.*, 2001).

3. RESULT AND DISCUSSION

The findings of this study are in the line of previous study (Thompson *et al.*, 2001) that effects of music attributed to differences in arousal and mood, as well as enjoyment. Participants who listened to Mozart scored significantly higher on positive mood and arousal and significantly lower on negative mood compared with their counterparts who listened to Albinoni. Enjoyable stimuli statistically induced positive affect and heightened levels of arousal, which lead to modest improvements in performance on visual graphic perception. Thompson *et al.* (2001) stated that listeners' use of music shows as an agent of emotional change. Moreover, the results support previous studies suggesting that the short-term effects of listening to Mozart on spatial ability are an artifact of arousal and mood (Thompson *et al.*, 2001).

Analyses of the pre-test measures of arousal and mood (obtained before exposure to visual graphic or music) indicated no pre-existing differences between conditions. The three post-test measures of arousal and mood (obtained after exposure to visual graphic or music) were examined separately with mixed-design ANOVAs that had one within-subjects variable (music or visual graphic) and one between-subjects variable (Mozart or Albinoni). In each case, the two-way interaction was statistical significant between conditions, $F(1, 23) = 8.11$, $p < .05$, for POMS arousal; $F(1, 23) = 14.03$, $p < .05$, for POMS mood, and $F(1, 23) = 6.12$, $p < .05$, for subjective mood-arousal rating, respectively. To investigate these interactions further, we examined differences between groups (Mozart vs. Albinoni) separately on each measure. In the visual graphic condition, there were significant differences between the Mozart and Albinoni groups $F(1, 23) = 7.32$, $p < .05$. In the music condition, scores were higher in the Mozart group than in the Albinoni group on the POMS arousal subscale, $F(1, 23) = 9.56$, $p < .05$, and on the subjective mood-arousal rating, $F(1, 23) = 18.60$, $p < .001$, but scores in the Mozart group were significantly lower than scores in the Albinoni group on the POMS mood (Depression-Dejection) subscale, $F(1, 23) = 9.20$, $p < .05$. Enjoyment scores were also higher in the Mozart group, $F(1, 23) = 13.19$, $p < .01$.

The findings of this study reveal that participants performed levels of arousal and mood states after listening to a musical excerpts. The two musical excerpts induced different levels of arousal and mood. Participants who listened to Mozart scored significantly higher on positive mood and arousal (enjoyment rating, mood rating, POMS arousal score) and significantly lower on negative mood (POMS mood score) compared with their counterparts who listened to Albinoni. These findings provide the support for previous suggestions that the short-term effects of listening to Mozart on spatial ability are an artifact of arousal and mood (Chabris, 1999; Nantais and Schellenberg, 1999; Thompson *et al.*, 2001). According to Thompson *et al.*, (2001), the Mozart effect remained significant when POMS mood scores were partialed out. Thompson *et al.*, (2001) explain to this apparent discrepancy that the POMS mood subscale (Depression-Dejection) measures negative affect, whereas the enjoyment and mood ratings measured positive affect. However, some previous studies suggested that the positive and negative affect might be relatively independent and also influence to the cognitive performance in a non-monotonic manner as well as to be mediated by different neural pathways (Ashby *et al.*, 1999; Tellegen *et al.*, 1999). Thus, the present findings support previous study that the Mozart effect is associated more with positive than with negative mood (Thompson *et al.*, 2001).

It has been claimed that arousal and positive mood are not identical. Performance on certain tasks, such as creative problem solving, may be facilitated by positive affect but not by arousal (Thompson *et al.*, 2001). In addition, the effects of positive mood are associated with increased levels of dopamine, which project from the ventral tegmental area to several brain areas, including the locus ceruleus. The locus ceruleus, in turn, is the largest producer of norepinephrine, the neurotransmitter most strongly associated with arousal (Ashby *et al.*, 1999). Therefore, although mood and arousal rely on different neurochemical systems, these systems have overlapping neural substrates and may have similar effects on performance in many instances (Ashby *et al.*, 1999; Thompson *et al.*, 2001). Several studies confirms that arousal and mood influence performance on a variety of cognitive tasks (Isen, 1999; Davis and Thaut, 1989; Krumhansl, 1997; Scheibel, 1980; Sloboda, 1992; Thompson *et a.*, 2001). Such effects are evident with moderate changes in arousal or affect, which can be induced with ease (Thompson *et al.*, 2001). Changes in mood and arousal occur from moment to moment in response to environmental events (Isen, 1999; Scheibel, 1980). Music also affects arousal and mood, as evidenced by changes in skin conductance, heart rate, finger pulse amplitude, breathing rate, and other measures (Davis and Thaut, 1989; Krumhansl, 1997), and by listeners' use of music as an agent of emotional change (Sloboda, 1992). The arousal and mood explanation of the Mozart effect was entirely consistent with existing evidence (Thompson *et al.*, 2001).

Finally, the present result support previous study stating that brief exposure to music leads to short-term enhancement of non-musical skills is misleading. The Mozart effect can be explained simply that the enjoyable stimuli induce positive affect and heightened levels of arousal and mood state leading to modest improvements in performance on a variety of tasks (Thompson *et al.*, 2001). The findings provide compelling evidence that the "mysterious" Mozart effect studied by Steele *et al.*, (1999) can be explained by participants' mood and arousal level (Thompson *et al.*, 2001). The present results corroborate previous findings showing that visual stimuli have access to the early levels of auditory processing hierarchy (Klucharev *et al.*, 2003; Mottonen *et al.*, 2004; Sam *et al.*, 1991; Besle *et al.*, 2004; Calvert *et al.*, 2004; van Wassenhove *et al.*, 2005) and support the auditory integration models. Integration of auditory and visual information is primarily based on temporal and spatial coincidence of the stimuli. These mechanisms are important in audio-visual integration of speech perception as well (Klucharev *et al.*, 2003; Calvert *et al.*, 2004). Consequently, the present investigation is the first to examine directly the contribution of arousal and mood to the Mozart listening compared to seeing visual graphic condition. Changes in mood may be induced by giving participants a visual graphic, and changes in arousal occur in response to environmental events.

4. CONCLUSION

Our results support previous studies suggesting that the short-term effects of listening to Mozart on spatial ability are an artifact of arousal and mood. The present investigation is the first to examine directly the contribution of arousal and mood to the Mozart listening compared to seeing visual graphic condition in tonal (Thai) speaker. The audiovisual interaction is an indicator for investigating the automatic processing of acoustic sound perception. Changes in mood may be induced by giving participants a visual graphic, and changes in arousal occur in response to environmental events.

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