Research Report

THE MOZART EFFECT: An Artifact of Preference

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Abstract—*The "Mozart effect" reported by Rauscher, Shaw, and Ky (1993, 1995) indicates that spatial-temporal abilities are enhanced after listening to music composed by Mozart. We replicated and extended the effect in Experiment 1: Performance on a spatial-temporal task was better after participants listened to a piece composed by Mozart or by Schubert than after they sat in silence. In Experiment 2, the advantage for the music condition disappeared when the control condition consisted of a narrated story instead of silence. Rather, performance was a function of listeners' preference (music or story), with better performance following the preferred condition.*

Claims that exposure to music composed by Mozart improves spatial-temporal abilities (Rauscher, Shaw, & Ky, 1993, 1995) have received widespread attention in the news media. Based on these findings, Georgia Governor Zell Miller recently budgeted for a compact disc or cassette for each infant born in state. Reports published in *Science* (Holden, 1994), the *APA Monitor* (Martin, 1994), and the popular press indicate that scientists and the general public are giving serious consideration to the possibility that music listening and music lessons improve other abilities. If these types of associations can be confirmed, the implications would be considerable. For example, listening to music could improve the performance of pilots and structural engineers. Such associations would also provide evidence against contemporary theories of modularity (Fodor, 1983) and multiple intelligences (Gardner, 1993), which argue for independence of functioning across domains.

Although facilitation in spatial-temporal performance following exposure to music (Rauscher et al., 1993, 1995) is temporary (10 to 15 min), long-term improvements in spatial-temporal reasoning as a consequence of music lessons have also been reported (Gardiner, Fox, Knowles, & Jeffrey, 1996; Rauscher et al., 1997). Unfortunately, the media have not been careful to distinguish these disparate findings. The purpose of the present study was to provide a more complete explanation of the short-term phenomenon. Rauscher and her colleagues have proposed that the so-called Mozart effect can be explained by the *trion model* (Leng & Shaw, 1991), which posits that exposure to complex musical compositions excites cortical firing patterns similar to those used in spatial-temporal reasoning, so that performance on spatial-temporal tasks is positively affected by exposure to music.

On the surface, the Mozart effect is similar to robust psychological phenomena such as transfer or priming. For example, the effect could be considered an instance of positive, nonspecific transfer across domains and modalities (i.e., music listening and visual-spatial performance) that do not have a well-documented association. Transfer is said to occur when knowledge or skill acquired in one situation influences performance in another (Postman, 1971). In the case of the Mozart effect, however, passive listening to music—rather than overt learning—influences spatial-temporal performance. The Mozart effect also bears similarities to associative priming effects and spreading activation (Collins & Loftus, 1975). But priming effects tend to disappear when the prime and the target have few features in common (Klimesch, 1994, pp. 163–165), and cross-modal priming effects are typically weak (Roediger & McDermott, 1993). Moreover, it is far from obvious which features are shared by stimuli as diverse as a Mozart sonata and a spatial-temporal task.

In short, the Mozart effect described by Rauscher et al. (1993, 1995) is difficult to situate in a context of known cognitive phenomena. Stough, Kerkin, Bates, and Mangan (1994) failed to replicate the findings of Rauscher et al., although their use of Raven's Advanced Progressive Matrices rather than spatial tasks from the Stanford-Binet Intelligence Scale (Rauscher et al., 1993, 1995) to assess spatial abilities may account for the discrepancies. Whereas tasks measuring spatial recognition (such as the Raven's test) require a search for physical similarities among visually presented stimuli, spatial-temporal tasks (e.g., the Paper Folding and Cutting, PF&C, subtest of the Stanford-Binet; mental rotation tasks; jigsaw puzzles) require mental transformation of the stimuli (Rauscher & Shaw, 1998). In their review of previous successes and failures at replicating the Mozart effect, Rauscher and Shaw (1998) concluded that the effect is obtainable only with spatial-temporal tasks.

Our goal in Experiment 1 was to replicate and extend the basic findings of Rauscher et al. (1993, 1995). A completely computer-controlled procedure was used to test adults' performance on a PF&C task immediately after they listened to music or sat in silence. Half of the participants listened to Mozart during the music condition; the other half listened to Schubert. The purpose of Experiment 2 was to test the hypothesis that the Mozart effect is actually a consequence of participants' preference for one testing condition over another, the assumption being that better performance would follow the preferred condition. Control conditions in Rauscher et al. (1993) included a period of silence or listening to a relaxation tape, both of which might have been less interesting or arousing than listening to a Mozart sonata. Consequently, if the participants in that study preferred the Mozart condition, this factor might account for the differential performance on the spatial-temporal task that followed. In a subsequent experiment (Rauscher et al., 1995), comparison conditions involved silence or a combination of minimalist music (Philip Glass), a taped short story, and repetitive dance music. Minimalist and repetitive music might also induce boredom or low levels of arousal, much like silence, and the design precluded direct comparison of the short-story and music conditions. Indeed, in all other instances in which the Mozart effect has been successfully replicated (see Rauscher & Shaw, 1998), control conditions consisted of sitting in silence or listening to relaxation tapes or repetitive music. In Experiment 2, our control condition involved simply listening to a short story.

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Table 1. *Mean number of items correct in Experiments 1 and 2*

		Condition			
		Music		Control	
Experiment	*N*				
1	28	Mozart	12.75 (3.38)	Silence	11.89 (3.59)
	28	Schubert	12.36 (4.05)	Silence	11.04 (4.61)
2	28	Mozart	13.00 (3.80)	Story	12.93 (2.91)

Note. Standard deviations are given in parentheses.

METHOD

Participants

We recruited 84 undergraduates: 56 for Experiment 1 and 28 for Experiment 2.

Apparatus and Stimuli

The first 10 min of Mozart's (1985, tracks 1–2) Sonata for Two Pianos in D Major, K. 448 (as in Rauscher et al., 1993, 1995) and the first 10 min of Schubert's (1985, track 4) Fantasia for Piano, Four Hands, in F Minor (D940) were digitally rerecorded from a compact disc onto a Power Macintosh computer using the SoundEdit 16 software program. Both pieces came from the same compact disc and were performed by the same two pianists. The sound quality was not adversely affected by the rerecording process (i.e., 16-bit sound files, sampling rate of 44.1 kHz). Stimulus presentation and response recording were controlled by a customized program created with PsyScope 1.1 software (Cohen, MacWhinney, Flatt, & Provost, 1993) installed on the computer. During testing, listeners received a stereo signal over lightweight headphones (Sony CD550) in a sound-attenuating booth (Eckel Industries).

The control condition in Experiment 1 consisted of sitting in silence for 10 min. In the control condition of Experiment 2, participants listened to 10 min of the short story "The Last Rung on the Ladder" (King, 1994), which was also rerecorded from audiocassette onto the hard disk of the computer. A short story was selected as an auditory stimulus that would be engaging without being overly arousing, much like music composed by Mozart.

Participants used a mouse connected to the computer to initiate a 10-min listening period and to record their responses on the subsequent PF&C task, which included 34 items (20 from the Stanford-Binet Intelligence Scale, 14 created for the experiment) that were scanned into the computer. Each item had an upper panel that showed a rectangular piece of paper and a series of folding and cutting manipulations, plus a lower panel with five possible outcomes. The relative difficulty of the items was determined in a pilot study in which 20 university students completed the entire set of items presented in random order. Following the pilot study, two 17-item subsets of equal difficulty were formed.

Design and Procedure

Each student participated in two conditions (music and control) on separate days within a maximum of 2 weeks. In both conditions, the task was administered after a 10-min listening period. In the music condition, participants listened to the Mozart or Schubert piece. Immediately afterward, each of 17 PF&C items was displayed on the computer monitor for a maximum of 1 min, and participants selected one of the five unfolded displays as the appropriate outcome. The 17 items were ordered from least difficult to most difficult. No feedback was provided. Sessions took approximately 25 min to complete.

In Experiment 1, half of the 56 participants listened to the Mozart piece in the music condition; the other half listened to Schubert. In Experiment 2, all 28 participants listened to Mozart in the music condition. Control conditions were identical to the music conditions except that during the listening period, participants sat in silence wearing headphones (Experiment 1) or listened to a short story (Experiment 2). For each participant, different subsets of 17 task items were used for the two testing conditions. Order of conditions was counterbalanced with order of subsets. After the second test session, participants in Experiment 2 were asked which condition (music or story) they thought was more interesting and which condition they preferred.[1]

RESULTS

Experiment 1

Means and standard deviations for the music and control conditions in Experiment 1 are provided in Table 1. A mixed-design analysis of variance (ANOVA) was used to examine performance as a function of condition (music or silence), musical piece (Mozart or Schubert), and testing order (first or second). A main effect of condition revealed that scores on the spatial-temporal task were higher after listening to music than after sitting in silence, $F(1, 52) = 15.16$, $p < .001$. Differences between conditions accounted for 20% of the within-subjects variance. A main effect of testing order (accounting for 8% of the within-subjects variance) indicated that performance improved from the first to the second session, $F(1, 52) = 6.20$, $p = .016$. None of the other main effects or interactions was significant. In short, the Mozart effect reported by Rauscher et al. (1993, 1995) was successfully replicated in a completely controlled laboratory setting. More important, when a piece by Schubert was substituted for the Mozart

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[1] We did not pose the same questions to participants in Experiment 1 because we assumed that the vast majority would prefer listening to music over sitting in silence.

piece used by Rauscher and her colleagues, an effect of equivalent magnitude was evident.

Experiment 2

Means and standard deviations for the music (Mozart) and control (story) conditions in Experiment 2 are provided in Table 1. An ANOVA that examined effects of condition (music or story) and testing order revealed a reliable order effect; performance improved from the first to the second testing session, $F(1, 26) = 4.31$, $p = .048$, and testing order accounted for 14% of the within-subjects variance. The main effect of condition was not significant (explaining less than 0.1% of the within-subjects variance) and did not interact with testing order. In other words, the Mozart effect disappeared when the control condition consisted of a story rather than silence.

The next set of analyses tested our hypothesis that performance would be a function of listeners' preference for the Mozart piece or the short story. Each participant considered his or her "preferred" condition to be more "interesting" as well, so participants' responses were treated simply as a preference factor (13 preferred Mozart, 15 preferred the story). Mean levels of performance as a function of listeners' preference are provided in Table 2. As predicted, overall levels of performance were better in participants' preferred condition (M = 13.57, SD = 3.07) than in their nonpreferred condition (M = 12.36, SD = 3.56), $t(27) = 2.94$, $p < .001$ (one-tailed). An ANOVA with three factors (condition, testing order, and preference) confirmed that preference interacted with condition, $F(1, 24) = 5.02$, $p = .035$. Whereas participants who preferred the Mozart excerpt scored significantly higher in the Mozart than in the story condition, $t(12) = 3.77$, $p < .001$, participants who preferred the story exhibited marginally better performance in the story than in the Mozart condition, $t(14) = 1.49$, $p = .079$ (one-tailed tests). Listeners' preferences accounted uniquely for 15% of the within-subjects variance. Participants who preferred the Mozart piece also scored marginally higher than other participants across conditions, $F(1, 24) = 3.09$, $p = .092$.

DISCUSSION

The present study examined the effects of exposure to music on a subsequently presented spatial-temporal task. In Experiment 1, performance was better after participants listened to music composed by Mozart or Schubert than after they sat in silence. Although both pieces of music are relatively "easy listening" examples from the common-practice period, our finding makes it clear that the Mozart effect has nothing to do with Mozart in particular. Moreover, it seems likely that the effect would generalize to a wide variety of enjoyable pieces of music composed in the Classical (i.e., late 1700s; e.g., Mozart, Haydn) or Romantic (i.e., early 1800s; e.g., Schubert, Liszt) styles.

Indeed, this finding implies that a similar effect might be evident when any positive stimulus (musical or otherwise) is paired with a less engaging stimulus. We examined this possibility in Experiment 2 by substituting listening to a story for the silence (control) condition. Although performance in the Mozart and story conditions did not differ, listeners performed better following the condition they preferred. Thus, the spatial-temporal advantage reported by Rauscher et al. (1993, 1995) does not appear to be a consequence of listening to music per se. Rather, our results raise two possibilities. First, performance on spatial-temporal tasks may be enhanced after passive listening to a pleasant or interesting auditory stimulus. Second, decrements on such tasks may be the consequence of exposure to 10 min of a stimulus deemed to be relatively boring or unpleasant. Regardless, all previous findings of the Mozart effect (see Rauscher & Shaw, 1998)—in which a piece by Mozart has been paired with silence, a relaxation tape, or repetitious music—can be explained similarly.

Participants' preferences for one condition over another could have been accompanied by between-condition differences in mood or level of arousal. Although our lack of a direct measure of mood or arousal means that this proposal is speculative at the present time, it allows the seemingly enigmatic Mozart effect to be explained by well-known psychological phenomena. Emotional states consist of qualitative, cognitive aspects dependent on the context as well as quantifiable, physical aspects (Schachter, 1964), with mood associated with the former and arousal with the latter. In Experiment 1, positive mood states or elevated levels of arousal created by the music could have facilitated performance on the spatial-temporal task (Isen, Daubmann, & Nowicki, 1987). Alternatively, negative moods or decreased levels of arousal caused by sitting in silence for 10 min may have had a detrimental effect (O'Hanlon, 1981), or both of these factors may have been operative. For example, many adults report using music as an agent of emotional change (Sloboda, 1992). In the laboratory, "happy" music induces happiness, whereas "sad" music produces sadness (Parrott & Sabini, 1990). Exposure to "elated" music tends to increase heart rate and systolic blood pressure; "depressing" music has the opposite effect (Pignatiello, Camp, Elder, & Rasar, 1989). Exposure to "happy" music also results in faster speed and greater persistence on various tasks (Kavanagh, 1987). Conversely, states of boredom and low levels of arousal are associated with poor performance on a variety of perceptual, cognitive, and motor tasks (O'Hanlon, 1981). Negative emotions may decrease the efficiency of information processing relative to positive affective states (Wyer & Srull, 1989), causing decrements in learning and performance (Boyle, 1983). Future research could test our speculation that participants' preferences are accompanied by changes in mood or arousal.

In sum, although listening to music composed by Mozart might contribute to improved performance on a subsequently presented spatial-temporal task, our results provide no evidence that the improvement differs from that observed with other engaging auditory stimuli that are equally pleasing to participants.

Table 2. *Mean number of items correct in Experiment 2 as a function of listeners' preference*

		Condition	
Preference	*n*	Mozart	Story
Mozart	13	14.62 (2.40)	13.23 (2.35)
Story	15	11.60 (4.29)	12.67 (3.37)

Note. Standard deviations are given in parentheses.

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