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Reexamination of the Effect of Mozart's Music on Spatial-Task Performance

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ABSTRACT. The spatial reasoning of 22 college undergraduates who had listened to a presentation of Mozart's music was examined under carefully controlled experimental conditions. Each participant performed a pencil-and-paper maze task after a 10-min presentation of each of three listening conditions: a piano concerto by Mozart, repetitive relaxation music, and silence. Mazes varied in complexity of solution and size. Limited support for the previously obtained enhancing effect of listening to Mozart's music was revealed in measures of performance accuracy on this spatial task, whereas no effect was found for either the number of maze recursions or the overall quality of maze solutions. These findings are discussed in relation to the need for further replication of the effect before strong claims of generalizability may be made.

THE FACILITATING EFFECTS of the music of Wolfgang A. Mozart on abstract cognitive operations (such as spatial reasoning) have become of popular interest (Bower, 1994; Holden, 1994; NBC News, 1994). Results of some investigations have suggested that listening to Mozart's music enhances performance on mathematical and spatial-reasoning tasks. For example, Rauscher, Shaw, and Ky (1993) gave research participants one of three standard tests of abstract spatial reasoning after they had experienced each of three listening conditions: a sonata by Mozart, relaxation instructions, and silence. These authors found that the mean standard age scores converted into IQ scores were 8 to 9 points higher after the participants had listened to the music than after either of the other two conditions. This effect has been attributed to a priming-like activation of organized neural pathways that are assumed to underlie the structures of both the complex, patterned music of Mozart and certain spatial tasks (e.g., NBC News, 1994). We took exception to the findings of the apparent influence of classical music such as Mozart's on methodological grounds and proceeded to reexamine the effect.

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Traditional wisdom based on neuropsychological research has localized both visuospatial functions and musical ability in the right cerebral hemisphere (e.g., Chase, 1966; Kimura, 1964; Shankweiler, 1966). Wagner and Menzel (1977) demonstrated that listening to music stimulates both alpha and beta brain-wave activity in humans. The positive effects of various musical stimuli have been examined more recently in the domains of learning and achievement (Karper, 1979; Schreiber, 1988) and stress reduction (e.g., Stratton, 1992). Recent interest in the specific effects of the music of Mozart also has increased in popular fascination (NBC News, 1994, p. 14); however, not a great deal of evidence has been produced in support of an enhancing effect of patterned classical music, such as Mozart's, on spatial-reasoning operations. Because the possibility exists that the so-called Mozart effect results from the specific procedures and tests used by Rauscher et al. (1993), we believe that replication of the finding, once again under careful experimental control and analysis of order effects, should be attempted.

In the present experiment, we used listening conditions similar to those used by Rauscher et al. (1993), including the music of Mozart, a relaxation condition, and silence. In their correspondence, Rauscher et al. reported that the effect of Mozart's music could not be attributed to arousal level as measured by pulse rate, pre- and posttest, and these investigators "found no order effects for either condition presentation or task." To investigate the generalizability of these findings, we tested the spatial reasoning of the participants in the present study by having them complete pencil-and-paper mazes of varying complexity. If the Mozart effect (NBC News, 1994) is replicable, then the participants' performances on the mazes should be enhanced after listening to Mozart's music relative to the other two listening conditions. Furthermore, the order of the listening conditions should not be a significant factor in their performance.

Method

Participants

The participants were 22 volunteers who were undergraduate students ranging in age from 18 to 21 years. There were 11 men and 11 women from an introductory psychology course at Bellarmine, a small liberal arts college. The participants received compensation in the course for their participation.

Materials

Following the method used by Rauscher et al. (1993), we presented three listening conditions, each exactly 10 min long. An audiocassette tape was prepared, on which the three different listening conditions were presented in three different orders, and the participants heard the tape via a standard cassette taperecorder. In one listening condition, the participants heard a portion of Mozart's Piano Concerto No. 23 in A major, K488, a musical stimulus that meets the criteria of complexity and patterning (NBC News, 1994, p. 15). The second listening condition was a recording of relaxation music described as repetitive angelic female voices, rather than complex and patterned classical music. We chose an alternative musical stimulus to the vocal relaxation instructions used by Rauscher et al., in order to provide a musical control. The third listening condition was silence.

The participants' spatial-reasoning task was to complete nine pencil-and-paper mazes. The three sets of three mazes each varied in complexity and size. For example, three of the nine mazes were very simple in structure, roughly 40 sq. in. Another three mazes were taken from a children's book by Nevins (1989) and were more complex in that they were three-dimensional presentations, with somewhat longer solution paths and more alternative path choices than the simple mazes had. These mazes averaged 70 sq. in. in size. The remaining set of three mazes, taken from Phillips (1978), had the highest degree of complexity in terms of alternative path choices, and the solution path took the greatest number of turns, covering 80 sq. in.

Design and Procedure

We used a 3 × 3 Latin square design in which both the listening conditions and the maze complexity were within-subject. The participants were randomly assigned to one of three presentation orders for the listening conditions. Thus, the classical music condition was presented first for some participants, second for others, and third for others. They participated in small groups of 3 to 7.

One presentation order was examined on each of three separate days. The experimental session began with the same tape-recorded instructions for all groups. The participants were told to "work as quickly as possible and be precise." A booklet of mazes lay face down on the desk in front of each person. Once they had started to complete each maze, the participants were instructed not to pick up the pen from the paper until they had reached the goal. After the instructions were given, the first listening condition was presented for 10 min. After the listening period, the participants began work on the first of the three sets of mazes, one from each level of complexity. They were given 8 min to complete the mazes; they used identical Bic Paper-Mate, medium ball-point pens. A pilot study indicated that this type of pen led to more reliable measures of path errors and path recursions. The same procedure was used for each of the remaining two listening conditions. After the third 8-min maze completion period, the experimental session ended with an oral debriefing of the group by the experimenter.

We focused on four measures of maze performance to index the participants' spatial reasoning. First, we counted the number of mazes completed within each condition as an overall measure of performance. A second accuracy measure, number of path errors, was determined by a count for each maze of the number of times a person took a path that led to a dead end or moved into a region of the maze that was not part of the best solution. The third measure was a gross assessment of the quality of each maze solution: the number of times participants picked up their pens and broke the solution path. Finally, we counted the number of times they had to turn back with a recursion in their solution.

Results

The hypothesis that listening to the classical music of Mozart enhances spatial-reasoning operations received support from our data. The mean number of mazes completed within the time allotted was greater after the participants listened to the music of Mozart ($M = 2.68$) than after experiencing the relaxation music ($M = 2.27$) or the silence condition ($M = 1.73$), $F(2, 38) = 9.44$, $p < .001$. An a priori paired t test of the means of the control conditions revealed that the participants completed significantly more mazes after listening to relaxation music relative to silence, $t(21) = 1.97$, $p < .04$. No effect of order of listening condition was found for maze completion.

The second measure, mean number of path errors, was lower after the participants listened to Mozart ($M = 1.14$) than after they listened to the relaxation music ($M = 2.0$) or heard silence ($M = 2.82$). A 3×3 repeated measures analysis of variance revealed a main effect of listening condition on the number of path errors, $F(2, 38) = 8.296$, $p < .01$. The difference in mean number of path errors between the two control conditions merely approached a level of significance, $t(21) = -1.68$, $p < .06$, in favor of fewer errors in the relaxation-music condition. In addition, there was a significant main effect for order of listening condition on mean number of path errors, $F(2, 19) = 4.275$, $p < .03$. Those participants who were presented with the classical music condition last performed with fewer errors ($M = 1.10$) than those who were presented with the Mozart condition followed by silence or relaxation music ($M = 2.83$ and 1.91, respectively).

No reliable interaction between listening condition and presentation order was obtained. Thus, the accuracy of the performance was an additive function of the listening condition at the time of test and the specific order in which the listening conditions were presented. The data revealed no reliable effects of the experimental conditions on the remaining two measures of spatial-task performance, all $ps > .10$.

Discussion

The results of this study demonstrate that listening to the patterned classical music of Mozart can indeed enhance performance on some measures of spatial reasoning. It appears that Mozart's music is sufficient to improve accuracy on this spatial-reasoning task relative to relaxation music or silence stimulus conditions. However, the results of the accuracy measures suggest that listening to passages of repetitive relaxation music can also enhance spatial-task performance relative to silence.

Although the effect of Mozart's music was greater than that of the relaxation music on the measures of accuracy, the participants performed the best on the last block of mazes when they had the silence condition first, followed by the relaxation music, and then Mozart's music. The results provide limited support for a relationship between listening to complex and patterned classical music and spatial cognitions of the type examined here. Contrary to the predictions of Rauscher et al. (1993), our data demonstrate that music that is repetitive and lacking in complexity may enhance accuracy in spatial reasoning as well, rather than interfering with it relative to silence. Given that the present data show no evidence for the effect of Mozart's music on two of the four measures, combined with evidence of an additive effect of listening condition and order of stimulus presentation, we believe the precise nature of the Mozart effect and the conditions under which it is revealed remain in question.

With reference to the Mozart effect, it has been reported elsewhere that "anyone can benefit from this" (NBC, 1994, p. 16). The present data suggest that the effect of listening to the music of Mozart on spatial reasoning is not so robust or powerful; it can enhance spatial-task performance under certain circumstances and to a certain point. Similarly, others have discussed the temporal limitations of the effect (Holden, 1994; Rauscher et al., 1993). Thus, we believe caution should be used before making strong claims about the generalizability of the Mozart effect. We urge researchers to continue examining the effects of patterned classical music, such as Mozart's, under varying listening conditions and with a variety of measures of spatial reasoning in order to explore external validity. In addition, studies that examine the possible enhancing effects of patterned stimuli other than music may be fruitful. To conclude that "anyone can benefit" in the performance of certain tasks from the music of Mozart goes beyond the boundary conditions investigated to date.

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