

EFFECTS OF LISTENING TO MOZART AND BACH ON THE PERFORMANCE OF A MATHEMATICAL TEST¹

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Summary.—The purpose of the current study was to assess the effect of listening to Mozart and Bach on the immediate performance of a 10-min. mathematical test. The study consisted of 61 undergraduate participants. Participants were randomly assigned to a control group, a Mozart group, or a Bach group. Participants were then administered a mathematics pretest, listened to a selection of music for 10 min., and were then administered a mathematics posttest. The test was constructed to be similar to items taken from the University Mathematics Placement Examination. Analysis indicated no significant effect on the immediate mathematics test when participants listened to 10 min. of either Mozart or Bach. These findings suggest caution in measuring differences in various cognitive tasks as indicating increases in intelligence scores.

There has been some controversy in recent years over the finding by Rauscher, Shaw, and Ky (1993) that listening to some of Mozart's Sonata for Two Pianos in D Major improved subsequent performance on abstract or spatial reasoning tasks taken from the Stanford-Binet Intelligence Scale, Fourth Edition. This improvement was translated by Rauscher, *et al.* (1993) to be an increase in IQ of eight to nine points. In a recent meta-analytical review of 16 studies investigating the Mozart effect, Chabris (1999) concluded that improvement on spatial tasks after listening to Mozart is the result of an "enjoyment arousal" effect. Thus, the debate goes on, and there is no definitive answer to whether there is a Mozart effect. The popular press has capitalized on the findings by Rauscher, *et al.* (1993), often touting the potential benefits of listening to Mozart's music. However, other than those studies of the effect of Mozart's music on spatial tasks, no investigations have examined what, if any, improvement may be observed on other subsequent complex cognitive tasks after listening to Mozart's music.

In an attempt to replicate the Mozart effect, three additional studies utilized the Stanford-Binet Paper-folding and Cutting subtest and additional items constructed to be similar to that subtest (e.g., Rideout & Laubach, 1996; Rideout & Taylor, 1997; Rideout, Dougherty, & Wernert, 1998). These studies yielded small but statistically significant increases in the test scores of participants immediately following brief exposure to Mozart's So-

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nata in D Major (Rideout & Laubach, 1996; Rideout & Taylor, 1997; Rideout, *et al.*, 1998) and after a selection of music by Yanni which was judged to be similar to the Mozart piece in structure, tempo, melodic and harmonic consonance, and predictability (Rideout, *et al.*, 1998).

Similar studies were done using various other measures of spatial ability such as Raven's Progressive Matrices (Stough, Kerkin, Bates, & Mangan, 1994; Newman, Rosenbach, Burns, Latimer, Matocha, & Vogt, 1995), the Revised Minnesota Paper Form Board Test (Carstens, Huskins, & Hounshell, 1995), a backward digit span task (Steele, Ball, & Runk, 1997), and a mazes task (Wilson & Brown, 1997). Another study, Steele, Brown, and Stoecker (1999) inserted a verbal distractor between the pretest and the brief selection of the Mozart Sonata in an effort to produce the Mozart effect. This study which utilized the Paper-folding and Cutting items taken from the Stanford-Binet Intelligence Scale, Fourth Edition, along with the previously mentioned studies, yielded no significant effects as a result of listening to Mozart's music.

Rauscher, *et al.* (1993) suggested investigation into the effect listening to Mozart might have on quantitative reasoning. Although the review portion of the study conducted by Wilson and Brown (1997) indicated that previous investigations found that listening to Mozart increased immediate performance on mathematical as well as spatial tasks, a review of the literature undertaken by the current authors yielded no such studies have been performed. Finally, only a few studies have been conducted in which the effects of complex classical pieces of music, other than Mozart's music, have on complex cognitive tasks. Given the suggestion by Rauscher, *et al.* (1993), the lack of research investigating the effect of listening to Mozart's music on quantitative reasoning and the lack of studies investigating the effects of non-Mozart pieces of classical music on the performance of cognitive tasks, the purpose of the current study is to assess whether listening to Mozart or Bach will increase performance on a mathematics test.

METHOD

Participants

Sixty-one undergraduate students, 48 women and 13 men, from a small north Texas university volunteered and received additional credit for their participation. The ages of participants ranged from 18 to 50 years, with a mean age of 25.4. The majority (65.5%) were between the ages of 19 and 24 years. The self-identified ethnic makeup of the participants was as follows: 77.0% Euro-American, 11.4% African American/Black, 3.2% Hispanic, 1.6% Asian, and 6.5% Other. Participants indicated having attained mathematical achievement as follows: no mathematics ($n=2$), high school algebra

I, algebra II or geometry and no college mathematics ($n=16$), high school trigonometry or calculus and no college mathematics ($n=6$), college algebra ($n=26$), only college statistics ($n=3$), and college trigonometry or higher ($n=8$). Participants also indicated having 25 different academic majors, the largest number of whom were in psychology ($n=6$).

Apparatus

The room in which this study was conducted was a medium-sized lecture hall used for the teaching of several different courses by the music department. The room was selected for its size, the sound system installed in the room, and for its acoustic quality.

A mathematics test of 10 items was constructed in two alternate forms for use in this study. Items were constructed to be similar to those found on the University Mathematics Placement Examination given to incoming freshman students to determine placement in mathematics courses. The 10 items were of three difficulty levels. The first two items were the least difficult, the next six items were of medium difficulty, and the last two items were the highest level of difficulty. The test was designed to be taken in 10 minutes.

Procedure

Participants were assigned to a control group ($n=20$), a Mozart group ($n=20$), or a Bach group ($n=20$). This was achieved by contacting the participants and giving them a choice of three different days in which to take part in the study.

The study was conducted on three consecutive days at the same time each day. The control group was tested on the first day of the study, the Mozart group on the second day, and the Bach group on the third day. After participants arrived, a consent form was given to them to read and sign as well as demographic information sheet to fill out. Participants were then asked if they had any questions regarding the study. Once questions had been answered, subjects were asked to refrain from talking for the remainder of the session.

This study utilized a pretest/posttest design. The alternate forms of the mathematics test were counterbalanced. Prior to beginning the testing session, participants were told that no calculators could be used. Participants were then given 10 min. to complete the pretest. After the completion of the pretest, participants in the control group listened to 10 min. of ocean sounds, participants in the Mozart group listened to 10 min. of Mozart's Sonata for Two Pianos in D Major (Munves, 1995), and participants in the Bach group listened to 7 min., 49 sec. of the first movement, Allegro, and then 2 min., 11 sec. of the third movement, Presto, of Bach's Brandenburg Concerto Number 4 in G Major, BWV 1049. Following the music condition, participants were given 10 min. to complete the posttest.

RESULTS

Mean test scores improved across all three groups from pretest to posttest: control (4.90 to 5.35), Mozart (3.45 to 5.15), and Bach (3.76 to 4.38). Standard error of the test scores, pretest to posttest, are as follows: control (.460 to .436), Mozart (.460 to .436), and Bach (.449 to .425). An alpha level of .05 was used for all statistical tests. A one-way between-subjects analysis of variance tested for initial differences between groups. Results indicated no significant difference ($F=.70$, ns). A two-way mixed-design analysis of variance, with type of music the between-subjects factor and time of test the within-subjects factor, was used to evaluate statistical significance of the music treatment. The effect of music was not statistically significant ($F=1.19$, ns).

DISCUSSION

The current study demonstrates that listening to 10 min. of Mozart or Bach did not significantly increase immediate subsequent performance on a 10-min. mathematical test. These results are consistent with those studies which indicate listening to Mozart has no effect on the performance of spatial tasks (Stough, *et al.*, 1994; Carstens, *et al.*, 1995; Newman, *et al.*, 1995; Steele, *et al.*, 1997, 1999).

There are at least two plausible explanations for the current finding. In his explanation of the Mozart effect, Chabris (1999) pointed to the fact that difficult spatial tasks as well as cognitive arousal are associated with right hemisphere function; however, it may be that cognitive arousal and mathematical ability do not share the same right hemisphere locus. The second plausible explanation for the failure to find a Mozart effect in the current study, which was also suggested by Chabris (1999), is the mathematics test may not have been sufficiently arousing to subjects. This leads the authors of the current study to conclude that, while listening to a brief selection of Mozart or other complex musical pieces is of substantial aesthetic value, there is no indication that listening to classical music briefly increases immediate performance on cognitive tasks.

Finally, the manner in which Mozart's music is currently marketed by at least one company leads one to believe that listening to Mozart will increase one's IQ or performance on any test. Given that only a handful of studies indicate listening to Mozart increases immediate performance on a measure of spatial IQ, the current authors advise caution in endorsing listening to Mozart's music as a "quick and easy" way to increase performance on tests of cognitive ability.

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