The "Arousal Effect": An Alternative Interpretation of the Mozart Effect

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ABSTRACT

Previous research suggests that listening to Mozart's music enhances performance on subsequent tests of spatial ability. One explanation for this result is that Mozart's music produces a positive arousal state that increases alertness and thus, enhances spatial performance. In this study, we sampled elementary students in order to investigate (1) the presence of the Mozart effect and (2) the possibility that the Mozart effect can be explained by increased levels of arousal. We assigned participants randomly to (1) listen to Mozart (Mozart group), (2) play active games (active group), or (3) sit in silence (control group) prior to completing a spatial abilities task. We expected that (1) both the Mozart and active groups would perform better on the spatial test than the control group and (2) the active group would perform better on the spatial test than the Mozart group. Pre-planned orthogonal contrasts revealed that the Mozart and active groups outperformed the control group but the Mozart and active groups performed similarly. Implications of these data for understanding the Mozart effect and for improving grade school education are discussed.

I. INTRODUCTION

Music affects animals and human beings in a myriad of ways. Symphonic music increases chickens' egg output (18.9% more than a non-music group [1]) and cows' milk production (10-26% more than a non-music group [2]), and rats who are exposed to the Mozart Sonata (K.448) *in utero* plus 60 days postpartum are able to run a maze faster and with fewer errors than rats that have listened to minimalist music, white noise, or no music [3]. More importantly for the current study, music also enhances human performance on a variety of tasks.

For many years investigators have noted the positive effect of listening to music on an individual's performance in a wide range of situations. In an observational study Davidson and Powell [4] observed that background "easy listening" music improved fifth graders' performance of everyday tasks. Costa-Giomi [5] reported that children who received piano keyboard instruction scored significantly higher on spatial-temporal tests than did children who received computer lessons or no lessons, and Antrim [6] found that music influenced worker morale and production. According to Antrim, music improves assembly line performance, bolsters morale, relieves fatigue, and increases output. Finally, in Britain, school children performed better on tests when they listened to popular music or Mozart's music, rather than a scientific explanation, prior to the tests [7]. Interestingly, a number of studies have suggested that listening to Mozart's music enhances performance of spatial reasoning tasks. In this paper, we explore this phenomenon, referred to as the Mozart effect, and the mechanisms underlying it.

a. The Mozart Effect

Interest in the Mozart effect was prompted by a study that was carried out at the University of California, Irvine, and was reported in a letter to the British Journal *Nature* in October 1993 [8]. In this study, Rauscher and colleagues found that participants who listened to Mozart's *Sonata for Two Pianos in D Major* for ten minutes scored higher on the Stanford-Binet folding and cutting tasks than did participants who sat in silence for 10 minutes prior to the test [8]. Subsequent research by Rauscher and colleagues has suggested that the Mozart effect is observed only if the spatial test follows the presentation of music by 15 minutes or less [9]. Additionally, the effect is reliable only when pure measures of spatial reasoning are used (*e.g.*, the Stanford-Binet cutting and folding tasks [10]) but not when other, more general ability assessments are used (*e.g.*, Raven's progressive matrices [11-18]). Based on the discrepancies in past studies, we felt further investigation into this phenomenon was warranted. A primary goal of the current project was to investigate the reliability of the Mozart effect in a population of elementary-school children.

An additional objective of this project was to investigate the mechanism by which Mozart's music might enhance spatial task performance. Interestingly, this mechanism has not been confidently identified. Rauscher and colleagues have suggested that listening to music and executing spatial tasks share neural pathways in the cortex. According to this reasoning, listening to music serves to "prime" neural pathways for the subsequent execution of spatial reasoning tasks [14]. Consistent with this notion, and consistent with data reported by Rauscher and colleagues [8] three years earlier, Rider and Laubach [19] found that the EEGs of participants who performed a spatial task were similar to those of participants who listened to Mozart's music.

An alternative interpretation of the Mozart effect is that the increase in spatial task performance after listening to Mozart is due to increased arousal. C.E. Chabris [20] conducted 16 studies on the Mozart effect and was an advocate of this explanation. He concluded that, "...there may be a small intermittent effect (of the music) but that it probably arises from 'enjoyment arousal' induced by music." He speculated that sitting in silence or listening to a relaxation tape is less arousing than listening to Mozart. Thus, previous experiments on the Mozart effect may have confounded differences in listening conditions with differences in arousal and mood [21]. Similarly, Nantais and Shellenberg [22] speculated that sitting in silence decreases arousal and produces negative mood, which may have detrimental effects on task performance. In contrast, exposure to music has been proven to be an effective mood-induction technique, and musical selections by Mozart have even been employed to induce a mood of elation [23-24].

In a critical test of the role of mood and preference in the Mozart effect, participants listened to Mozart or to a passage from a story by Stephen King. Enhanced performance on spatial tasks only occurred if the subjects enjoyed what they heard. Therefore, those who liked listening to Stephen King did just as well on the spatial test as did those who liked listening to Mozart. Importantly, if participants did not enjoy the stimulus to which they were exposed (i.e., Mozart's music or the Stephen King reading), they did not perform as well [22]. Thus, it is possible that the Mozart effect has little to do with Mozart or even music in general. Instead, it may be a result of increased arousal and/or the facilitation of a positive mood [21]. In this project, we investigate the effect of arousal on spatial task performance in an effort to address the possibility that the Mozart effect is due to positive arousal rather than to neural priming.

a. Overview and Hypotheses

We assessed the Mozart effect in school-aged children who listened to Mozart's music, played active games, or sat in silence prior to completing a mood assessment and spatial abilities task. We expected that, independent of mood, the Mozart and active groups would perform better on the spatial task than would control participants. Additionally, we expected the active group to outperform the Mozart group on the spatial task.

II. METHOD

a. Participants and Experimental Design

We recruited 54 second through fourth-grade children from a before-school program at an elementary school in rural west-central Indiana. These 54 participants were assigned randomly to one of three experimental groups: (1) the Mozart group, (2) the active group, and (3) the control group.

b. Materials and Apparatus

Our experiment required the use of Mozart's *Sonata for Two Pianos in D Major*, which was played to the Mozart group. This composition was played at volume level 20 on a JVC "Kaboom Box" that was placed in the center of the room.

Mood assessment. The mood assessment consisted of eight items that assessed various emotions (e.g., Item #1: How happy do you feel?). Participants were given four choices for each item (e.g., very happy, a little happy, not happy, not at all happy). Additionally, a face that reflected the valence of each choice was placed below each item choice. Participants completed each item by circling the words/face that reflected most accurately their current emotional state.

Spatial abilities test. We used the Cognitive Abilities Test (the CogAt) to assess spatial performance. The CogAT is an age specific test that is given to children in grades K through 12 to measure the abstract reasoning abilities they have developed and the ability to apply these skills to given tasks [25]. This test contains three sections: verbal, quantitative, and nonverbal, and it is used to identify children for gifted programs. We used the "Figure Analysis" portion of the nonverbal section as the measure of spatial ability. For each item of this section, participants were given (1) a picture of a folded piece of paper in which holes had been punched and (2) four pictures of unfolded pieces of paper in which there were holes. The participants had to choose which of the four unfolded pieces of paper had holes that corresponded to those that were punched in the folded paper. This section of the test included 15 items.

b. Procedure

Informed consent forms were distributed to parents via their children. Only those children whose parents completed the consent form were allowed to participate in the project. The children completed the project in groups of 5-10 participants.

Participants were led from their school gymnasium to one of three rooms. As the first task of the experiment, participants assigned to the Mozart group sat quietly and listened to Mozart's *Sonata for Two Pianos in D Major* for ten minutes, participants assigned to the active group completed a variety of active games (e.g., jumping jacks, pass the ball, etc.), and participants assigned to the control condition sat in silence for ten minutes. After 10 minutes had elapsed, all groups were given the mood assessment test with no time limit. At the completion of the mood assessment test, it was collected, and the CogAT was distributed. Instructions for the test were given, and the children were allowed only 10 minutes to complete the test. Upon completion of the test, the children were given an oral debriefing and a reward for participating in our study.

III. RESULTS

We excluded from analyses three participants who answered no items correctly on the cognitive abilities test; we assumed that they did not understand the test. We compared the groups on the average number of CogAT items each participant completed correctly (out of 15 items). The active group had a mean composite test score of 12.17 (sd = 3.40), while the Mozart group had a mean composite test score of 10.94 (sd = 3.49). The control group had a mean composite test score of 9.42 (sd = 3.89). Consistent with expectations, the active group performed better than the Mozart group, and both the active and Mozart groups performed better than the control group.

To assess the significance of our results, we performed preplanned orthogonal contrasts that compared (1) the active group to the Mozart group and (2) the combination of the active and Mozart groups to the control group. Contrast one did not reach significance, B = -0.04, t (50) = -1.00, p = .32; statistically, the Mozart and active groups performed similarly. As a reminder, there was a descriptive difference between the two groups such that the active group outperformed the Mozart group. Contrast two reached significance, B = -0.10, t (50) =

-2.07, p = .04. Participants in the active and Mozart groups, together, performed significantly better on the CogAT than did participants in the control group. As a note, analyses controlling for mood, gender, and age produced results similar to those reported above.

IV. DISCUSSION

We investigated the Mozart effect in a sample of 54 school-aged children and compared the impact of listening to Mozart's music or doing active tasks to the impact of sitting in silence on spatial task performance. Consistent with hypotheses, participants who listened to Mozart's music and those who participated in active games performed better on the spatial abilities task than did participants who sat in silence. Interestingly, participants who listened to Mozart performed similarly to those who participated in active games. The data are consistent with the presence of the Mozart effect but also suggest that this effect may be due to arousal created by listening to the music. That is, both listening to Mozart's music and being physically aroused were associated with better spatial performance than sitting in silence.

There are a number of ways in which one might interpret these data and their implications for the Mozart Effect. First, the data are consistent with the notion that the "Mozart Effect" is due to physiological arousal that is inspired by listening to music. Following this reasoning, the active games and Mozart's music may have both inspired arousal, which may have increased participants' attention to and motivation to succeed on the spatial task, leading to elevated performance on the spatial test. Of course, our data cannot speak directly to this notion, as we did not include an objective measure of physiological arousal. However, subjective observations of participants in the active group suggested that they were aroused by the physical activity (e.g., participants were breathing at a faster rate after completing the active task than prior to the task). It is difficult to assess the arousal level of those participants in the other two groups without an objective measure; however, participants in the Mozart group seemed attentive to the music and those in the control group seemed bored by having to sit still.

On the other hand, it is entirely possible that our Mozart and active groups performed better, and similarly, on the spatial test (1) for a common reason, but one that is not related to arousal, or (2) for completely different reasons. That is, the active group's performance may have been enhanced by physiological arousal, whereas the Mozart group's performance may have been affected by the priming of neural connections, or by some other, non-arousal-related factor. Future research would do well to include an objective assessment of physiological arousal in order to shed light upon this issue.

It is important to note that mood is among the "common reasons" that might have affected the performance of both the active and Mozart groups; however, we controlled for mood in our analyses, and in these analyses mood did not account for enhanced performance after listening to Mozart's music or after playing active games. We should acknowledge, however, that we constructed the mood assessment for the purposes of the current study. Thus, it has not been independently validated.

a. Future Research Directions

While reflecting on our experiment, we identified several avenues for further investigation. First, in future studies it would be important to ask the participants whether or not they enjoyed the stimulus to which they were exposed. Indeed, Nantais and Schellenberg [22] found that people who enjoyed the stimuli performed better than those who did not care for it. Future research would do well to investigate experimentally the impact of enjoying a stimulus. For example, literature regarding the mere exposure effect suggests that repeated exposure to a stimulus increases attraction to that stimulus [26]. By manipulating the number of times participants listen to Mozart's music, one could enhance liking for the music and could then compare the spatial performance of participants who like the music (those who have heard it a number of times) to the spatial performance of those who hear it for the first time.

Future investigations of the Mozart effect could also focus on whether or not arousal, or Mozart's music, can enhance performance on non-spatial tasks. Including a measure of arousal should be part of any future studies addressing this issue. Though Rauscher and colleagues have suggested that the Mozart effect is specific to spatial tasks, their assertions were based on the notion that the Mozart effect depended upon priming of neural pathways that are similar to those employed in spatial tasks. Our data suggest that arousal may provide a valid explanation for the Mozart effect, and the impact of arousal on task performance may generalize beyond spatial tasks.

b. Implications

The current findings have practical implications for educational practices. The results suggest that the use of recess by schools may be beneficial. Since recess is typically physically arousing, it can be used as a tool by which schools may increase performance on spatial tests. In addition, if our results are applicable to other subject areas, schools could employ a special exercise program during times of standardized testing. Furthermore, our results support the idea that playing "complex" music in schools can improve performance on spatial tests. Schools could play music during break periods, lunch, recess, or allied arts, before class, and on the school bus before school.

c. Conclusion

The current data suggest that both listening to Mozart's music and participating in physically arousing tasks may enhance performance on a spatial test relative to sitting in silence. It is important to note that the positive impact of these experiences cannot be attributed to elevated mood, a fact which hints that physiological arousal enhances spatial performance via a cognitive path. Future research should investigate this cognitive explanation for elevated spatial performance and would do well to carefully delineate the role of familiarity with and affection for the presented stimulus. Finally, it is critical, regardless of the specific mechanism underlying the effect, that educators (and scientists alike) acknowledge the possibility that listening to music and taking part in physical activities can have positive consequences on academic performance.

AUTHORS' NOTE

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REFERENCES

1. Production Melody, *Time*, XL (November 2, 1942), *62*.
2. Is your milk bachized? *Etude* LXV (February 1947), 108.
3. Rauscher, F. H., Shaw, & G. L. (1998). Key components of the Mozart effect, *Perceptual and Motor Skills*, *86*, 835-841.
4. Davidson, C. W., Powell, L. A. (1986). The effects of easy-listening background music on the on-task-performance of fifth-grade children. *Journal of Educational Research*, *80*, 31-33.
5. Costa-Giomi, E. (1997). The McGill piano project: Effects of piano instruction on children's cognitive abilities In A. Gabrielsson (Eds.) *Third triennial conference of the European society for the cognitive sciences of music*. (pp. 446-450). Uppsala, Sweden: Uppsala University Press.
6. Antrim, D. K. (1943). 'Music in industry," *Musical Quarterly*. *29*, 275-290.
7. Hallam, S. (Ed.). (2002). Editorial. *Psychology of Music*, *30(1)*, 3.
8. Rauscher, F. H., Shaw, G. L., & Ky, K. N. (1993). Music and spatial task performance. *Nature*, *365*, 611.

9. Rauscher, F. H., Shaw, G. L., & Ky, K. N. (1995). Listening to Mozart enhances spatial temporal reasoning: Towards a neurophysiological basis. *Neuroscience Letters, 185*, 44-47.
10. Rideout, B. E., Dougherty, S., & Wernert, L. (1998). Effect of music on spatial performance: a test of generality. *Perceptual and Motor Skills, 86*, 512-514.
11. Carstens, C. B., Huskins, E., & Hounshell, G.W. (1995). Listening to Mozart may not enhance performance on the revised Minnesota paper form board test. *Psychological Reports*, *77*, 111-114.
12. Dalla Bella, S., Dunlop, T., Dawe, L., Humphrey, K., & Perez, L. (1999, April). *The Mozart effect revisited*. Paper presented at the annual meeting of the cognitive Neuroscience Society, Washington D.C.
13. Kenealy, P., & Monsef, A. (1994). Music and IQ tests. *The Psychologist*, *7*, 346.
14. Newman, J., Rosenbach, J. H., Burns, K.L., Latimer, B. C., Matocha, H. R., & Vogt, E. E. (1995). An experimental test of “the Mozart effect”: Does listening to his music improve spatial ability? *Perceptual and Motor Skills*, *81*, 1379-1387.
15. Steele, K. M., Bass, K. E., & Crook, M. D. (1999). The mystery of the Mozart effect: failure to replicate. *Psychological Science*, 10, 366-369.
16. Steele, K. M., Ball, T. N., & Runk, R., (1997). Listening to Mozart does not enhance backwards digit span performance. *Perceptual and Motor Skills*, 84, 1179-1184.
17. Stough, C., Kerkin, B., Bates, T., and Mangan, G. (1994). Music and Spatial IQ. *Personality and Individual Differences,* 17, 695.
18. Weeks, S.P. (1996). The effect of music on abstract/visual reasoning performance in high school music and non-music students. *Dissertation Abstracts International*, 56(9), 3408A.. (UMDI Dissertation Services No. 9600110)
19. Rideout, B. E., Laubach, C. M. (1996). EEG correlates of enhanced spatial performance following exposure to music. *Perceptual and Motor Skills*, 82, 427-432.
20. Chabris, C.E. (1999). Prelude or requiem for the “Mozart Effect”? *Nature*, *400*, 826.
21. Thompson, W., Schellenberg, E., & Husain, G. (2001). Arousal, mood, and the Mozart Effect. *American Psychological Society,* 12, 248-251.
22. Nantais, K. M., & Schellenberg E. G. (1999). The Mozart Effect: An Artifact of preference. *Psychological Science*, *10*, 370-373.
23. Kenealy, P. (1997). Mood-state-dependent retrieval: The effect of induced mood on memory reconsidered. *Quarterly Journal of Experimental Psychology*, *50A*, 290-317.
24. Westerman, R., Spies, K., Stahl, G., & Hesse, F. W. (1996). Relative effectiveness and validity of mood induction procedures: A meta analysis. *European Journal of Social Psychology*, 26, 557-580.
25. Riverside Publishing 2003, CogAT form 6. (2002). *A short guide for teachers version 1.1.* Retrieved March 23, 2003, from www.riverpub.com/products/group/cogat6/short.pdf
26. Bornstein, R. F. (1989). Exposure and Affect: Overview and Meta-Analysis of Research, 1968-1987. *Psychological Bulletin, 106,* 265-289.