# *The Mozart Effect and primary school children*

Psychology of Music

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vol 31(4): 405–413
[0305-7356 (200310)
31:4; 405–413; 035786]

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ABSTRACT This study found some evidence for the existence of a Mozart Effect with upper-primary school-aged children in a school setting. Scores on a Paper Folding Task (PFT) for a class which listened to Mozart during testing were significantly higher than the PFT scores of a control class. Moreover, a similar result was obtained for another class which listened to Bach during testing. The musical educational experience of the children, ascertained by a Musical Background Questionnaire, did not significantly contribute to the variance in PFT scores. We believe that this study is the first to find a Mozart Effect for school children in a natural setting, in contrast to the original study of Rauscher, Shaw and Ky (1993) who examined the effects of listening to Mozart on the spatial task performance of university students in a laboratory.

KEYWORDS: *music listening, spatial performance*

## *Introduction*

The *Mozart Effect* is the term used to label the temporary enhancement of spatial reasoning abilities immediately after listening to a piece of music by Mozart (Rauscher et al., 1993). In the original study, undergraduates exposed to Mozart's sonata for two pianos K.448 showed a significantly greater improvement in spatial IQ score, as determined by the relevant subtests of the Stanford-Binet Intelligence Scale applied immediately after the listening condition, than while listening to either a relaxation tape or silence.

More recently, the Mozart Effect has been used to refer to any reported cognitive enhancement associated with listening to the music of Mozart (Hughes et al., 1998). In this study we have employed the term in this wider sense by investigating the effects of concurrent rather than prior listening.

Whereas our interest was primarily in the Mozart Effect per se, we were aware of the (albeit circular) argument in some education circles that children in the classroom may generally benefit from the playing of suitable background music. Confirmation of the veracity of the Mozart Effect, then, is a matter of practical as well as theoretical interest. Rauscher et al. (1995) replicated the Mozart Effect, again with university students, but using only the Paper Folding and Cutting (PF&C) sub-test scores as their dependent variable. Interpreting this positive result as supporting their trion model of brain functioning, Rauscher et al. suggest that EEG coherence patterns should be informative of how listening to music enhances the organization of cortical firing patterns necessary for temporal-spatial performance. The suggestion has been taken up in several studies with positive results, e.g. increased EEG coherence (Sarnthein et al., 1999), and changes in amplitude of alpha rhythm and increased interhemispheric coherence (Iwaki et al., 1997). Moreover, increased physiological activity in the temporal and left frontal areas of the brain has also been observed in response to listening to Mozart's music (Rideout and Laubach, 1996). Nevertheless, suggestive as these findings are of a neural aetiology, the descriptive level of interest in this study was behavioural, as befitting a normal classroom setting.

Interestingly, Rideout and Laubach's finding may be consistent with the results of an earlier study on the cognitive demands of listening to Mozart's Quintet K.452, in which Marsden (1987) concluded that 'through all the changes of texture in the music, a more or less constant, and presumably optimal, complexity is maintained . . . [which] . . . is a function not simply of the objective pattern of notes but also of the cognitive strategy employed by the listener' (p. 50). Marsden suggests that the 'amount of cognitive processing performed by the listener [to Mozart] remains more or less constant' (p. 51), a conjecture which might explain why it is the music of Mozart rather than other composers that seems to best produce the effect. This conjecture finds support with an analysis of the dynamic fluctuations of K.448, often peaking every 30 seconds (Kliewer, 1999). '[S]equences in music repeating regularly every 20 to 30 seconds may trigger the strongest response in the brain, because many functions of the central nervous system, such as the onset of sleep and brain wave patterns, also occur in 30 second cycles' (p.37).

Thus, one important issue for interpretation of the Mozart Effect is the specificity of the stimulus. Wilson and Brown (1997) obtained the Mozart Effect with college students employing Mozart's Piano Concerto No.23 in A major, K.488. Some compositions of other composers have also enhanced spatial reasoning task performance, including the music of a popular New Age composer, Yanni, and the music of Schubert (Rideout et al., 1998; Nantais and Schellenberg, 1999; Rauscher, 1999). Consequently, Nantais and Schellenberg (1999) argue that there is nothing special about the music of Mozart, and that the Mozart Effect is an artefact of subject preference. In this study we addressed the issue of the specificity of music of Mozart by employing a piece of music by J.S. Bach as an alternate stimulus condition.

Kate Overy (1998), in a summary of the literature pertinent to the question ‘Can music really “improve” the mind?’, notes that evidence for the claim that music can enhance the development of intellectual skills such as abstract thinking and logical reasoning ‘is by no means conclusive’ (p. 97). While acknowledging ‘that music comprehension is not simply a perceptual phenomenon, but is dependent on a multitude of psychological and cognitive processes’ (p. 98), Overy questions whether such cognitive processes are necessarily developed, much less transferred to other cognitive domains, through an interaction with music.

Thus, there are a number of issues surrounding the Mozart Effect which justified its further investigation. First, much of the controversy about the Mozart Effect studies has been generated by the misconception that Mozart’s music can enhance general intelligence (Stough et al., 1994; Newman et al., 1995; Steele et al., 1997; Rauscher, 1999). Second, there still remains a lack of certainty about the necessary qualities of music that contribute to a Mozart Effect. Are any or all of the works of Mozart adequate? What criteria could be applied to the opus of other composers? Third, demographic and personal variables may contribute to the variance of the reported effect sizes (Hetland, 2000). Fourth, it may not matter to the classroom teacher just how the Mozart Effect works, if lasting real improvements can result. However, it is not clear that, given the short term nature of the Mozart Effect, the same phenomena are involved with improvements in some academic performance which have been found after periods of musical performance training, especially keyboard playing (Geake, 1996; Rauscher et al., 1997). Fifth, it was of concern to us that all Mozart Effect studies with students reported at the time of our study had been undertaken in laboratory conditions with young adults.

Two recent studies have addressed this issue. Savan (1998, 1999) found a Mozart Effect (in its more general sense) with small classes of boys aged 11–12 years who were categorized as having special educational needs and emotional and behavioural difficulties. In contrast, like many other researchers (e.g. Steele et al., 1999), Hallam (2000) found no evidence for a Mozart Effect (in the original limited sense) in a very large study of over 8000 children aged 10–11 years across 150 UK primary schools. Hallam concludes that previous positive results can be explained by differences in pre-test arousal.

## Method

The subjects were 76 (34 males and 42 females) Grade 5 and 6 school students from one primary school in Melbourne, Australia, ranging in age from 10 to 12 years ($M$ = 11.09 years), and distributed across three mixed ability classes. Class membership was originally determined randomly from the whole year listing of potential Grade 5 and 6 students. The three treatment conditions were randomly allocated to the three classes. Testing took place in normal school hours and in the subjects' normal classrooms in the same building, so that the school background noise which subjects were exposed to was very familiar. The three treatment conditions were:

a. prior and concurrent listening to Mozart's Sonata in D major K.448 for two pianos (Philips, 1991);
b. prior and concurrent listening to Bach's Toccata in G major, BWV 916 performed on piano (Sony Classical 1979);
c. listening to the background noise (control).

There were 28 students in the class listening to Mozart's music, 25 students in the class listening to Bach's music and 23 students in the non-music listening control class. A Panasonic portable CD player was used to play the music for the Mozart and Bach groups. The volume was adjusted for comfortable listening.

Temporal–spatial reasoning ability was measured by an age-normed (age group 10–12 years) PFT (Fitzgerald, 1978). The PFT asks respondents to imagine how a piece of paper, which has been folded several times and had a hole punched through the folded portion, will look when unfolded. Each subject was provided with a copy of the PFT on three sheets of A3 sized paper. There was no time limit for subjects to complete the PFT, following Silverman (1999) who argues that the nature of temporal-spatial reasoning is such that the assessment of these abilities is better undertaken under *untimed* conditions. Most of the children completed the instrument within 10 minutes.

The subjects in the music treatment groups (a) and (b) listened throughout the testing time including while the instructions of the PFT were being explained. This continuous listening protocol was used here to more closely simulate the sorts of recommended conditions for the use of music in school classrooms. For similar reasons, music was played to the whole class on a CD player rather than to individuals listening through headphones as in previous Mozart Effect studies.

The duration of the first Allegro con spirito movement of the Mozart Sonata at 8'23" was similar to that of the Bach Toccata (8'52"). The Mozart Group listened to all three movements of Mozart's Sonata in D major for Two Pianos, K.448, for a total duration of about 30 minutes. Only the first movement of the sonata was repeated. The Bach Group listened to Bach's Toccata in G major, BWV 916, repeated almost four times for a duration of about 30 minutes. The procedure for testing the Control Group was similar except that the subjects had only the unmediated background noise of the school to listen to.

It is important to note that this study was a treatment(s) versus control, rather than pre-test versus post-test design. Nevertheless, the assumption that the classes were ability-matched through the school's random allocation of students seemed reasonable. Moreover, this study had a larger *N* and a greater intellectual range of subjects compared with the number and intellectual range of the Ivy League university students originally tested by Rauscher and Shaw.

Additionally, a brief Musical Background Questionnaire was used to assess the subjects' musical experience, especially those who learned an instrument outside of school. Six questions sought information about:

- the duration of time children had spent playing musical instruments;
- which instruments the children were currently playing now;
- whether they had additional private music lessons outside of school; and,
- the duration of time they had had musical lessons.

In addition, information about the children's level of achievement in Australian Music Examinations Board and/or Suzuki exams was sought. The Musical Background Questionnaire was administered by the class teachers prior to the commencement of testing.

## *Results*

The main research question about group differences in the mean scores on the PFT was addressed by a one-way ANOVA with LSD post-hoc tests (Table 1). The effect for Group was significant ($F(2,73) = 4.47$, $p > .015$, eta squared = 0.109). The mean PFT score of the Mozart Group (6.29) was significantly higher than that of the Control Group (5.09). This result demonstrates a Mozart Effect for upper-primary school-aged children.

TABLE 1 *ANOVA of treatment on PFT performance*

| Treatment | *N* | PFT mean | SD | Mean difference | LSD sig |
|---|---|---|---|---|---|
| Mozart Group | 28 | 6.29 | 1.49 | 1.20 | .005 |
| Bach Group | 25 | 6.08 | 1.38 | 0.99 | .024 |
| Control Group | 23 | 5.09 | 1.62 | | |

Moreover, the mean PFT score of the Bach Group (6.08) was significantly higher than that of the Control Group (5.09). This result is indicative of a *Bach Effect* in parallel with the Mozart Effect, i.e. listening to some music of Bach had a similar effect to listening to some music of Mozart on the PFT performance of these upper-primary school children.

The subsidiary research question was concerned with the effects of musical experience as a possible explanatory variable. Twenty subjects out of the 76 had music lessons outside of school. Unsurprisingly, the musical education experiences of these children were quite varied, so much so that the only way to collapse these data seemed to be to create a global variable 'Extent of musical background' (MB). Consequently, subjects were allocated one of three MB values: 0 = no musical experience (no extra music lessons); 1 = beginners' level (0–1 years of music lessons inclusive); or, 2 = a higher level of musical experience (more than 1 year of music lessons outside of school). A one-way ANOVA with MB as the independent variable and PFT score as the dependent variable showed that the effect for musical experience was not significant ($F(2,73) = 1.76$, $p > .179$), even at the relaxed 90 percent significance level. (A two-way ANOVA of Group by Musical Background on PFT was not undertaken because of the small sizes of many cells.) Although the mean PFT scores increased monotonically with musical experience (Table 2), the result indicates that musical experience did not contribute a significant amount to the variance in PFT performance attributed to the Mozart and Bach treatment conditions.

TABLE 2 *ANOVA of musical background on PFT performance*

| Musical background | *N* | PFT mean | SD |
|---|---|---|---|
| No extra music lessons | 56 | 5.66 | 1.54 |
| 0–1 year of music lessons extra-school | 11 | 6.27 | 1.90 |
| More than one year of music lessons extra-school | 9 | 6.56 | 1.01 |

The gender of each subject was also noted at the time of testing. A two-way ANOVA of Group by Gender was not significant ($F(1,74) = 1.63$, $p > .206$). Finally, the age of each subject was recorded. The age range was too small for grouping for ANOVA, so a Pearson's correlation of age with PFT score was undertaken, but was not significant ($R = .104$, $p > .372$). Thus, neither of the demographic variables of gender or age contributed significantly to the variance of the PFT scores.

## *Discussion*

The superior performance on an appropriately age-normed PFT by upper-primary school children listening to the music of Mozart compared with the performance of peers who listened to background school noise is consistent with the findings of previous studies which found evidence for the Mozart Effect (e.g. Rauscher et al., 1993, 1995; Rideout and Laubach, 1996; Rideout and Taylor, 1997; Wilson and Brown, 1997; Rauscher and Shaw, 1998; Nantais and Schellenberg, 1999; Rideout et al., 1998).

However, this study was different from previous Mozart Effect studies in several aspects. First, the subjects were upper-primary school children in their natural school setting instead of university students in a laboratory setting. Second, unlike in other studies where the control condition was a quite unnatural silence, the Control Group in this study listened to familiar background noise. Third, the music was played before and during the administration of the PFT. We suggest that these differences contribute to the generalizability of the Mozart Effect by extending both subject and setting.

Moreover, in our experience, children of this 10–12-year-old age group today are not particularly enamoured of classical or baroque music. It was thus felt unnecessary to ask these subjects about their responses to listening to the music of Mozart or Bach. In any case, only 20 subjects were undertaking instrumental tuition outside of school. Thus, enjoyment seems unlikely to be a predominant explanation for the Mozart Effect that was found here. On the other hand, novelty or some kind of mood enhancement may well have contributed to the variance.

This study found that the effect of listening to Bach's Toccata in G major, BWV 916 on PFT performance was similar to that of listening to Mozart's Piano Sonata in D major, K.448. This was the first study that we are aware of that examined the effects of listening to the music of Bach within a Mozart Effect paradigm. This result is consistent with Nantais and Schellenberg (1999) who report a similar *Schubert Effect*, suggesting that the Mozart Effect may not be exclusive to the music of Mozart.

As with Savan (1999), continuing to play the stimulus music as background music during the testing period was an important difference between this study and previous Mozart Effect investigations. Whereas some researchers have found a positive effect of background music on cognitive task performance (Cockerton et al., 1997), others have argued that background music could be distracting to cognitive task performance (Sarnthein et al., 1999). Here, the findings are consistent with the former position, perhaps not surprisingly since children's everyday classroom conditions are replete with background noise. Perhaps the stimulus music brought some cohesion to the background noise which facilitated task performance (Cash et al., 1997).

Such a conjecture is broadly consistent with the explanation of an enhanced arousal effect proposed by several teams of researchers (e.g. Chabris, 1999; Hallam, 2000), although it is difficult to explain how arousal could only be manifest in an enhancement of spatial performance rather than of a broad range of cognitive tasks. The arousal hypothesis could be tested directly with a study design involving a non-music arousal control group *together with* a wider set of cognitive tasks as dependent variables. Hallam (2000) employed the first condition, a non-musical control group, and found no difference in spatial reasoning scores from those who listened to music. However, when a wider set of dependent variables were measured, Savan (1999) found that listening to Mozart during the task made a difference, but there were no non-musical control groups.

Unlike the findings of Rauscher et al. (1997) with pre-school children, and the results of Gardiner et al. (1996), the subjects in this study with a greater musical background did not demonstrate a significantly better performance on the spatial reasoning task. However, the size of the experienced group was too small to be conclusive.

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