

The Cognitive and Academic Benefits of Music to Children: Facts and fiction

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There is considerable interest in the potential non-musical cognitive and academic benefits of music listening and instruction to children. This report describes three lines of research relevant to this issue, namely, the effects of: (1) focused music listening on subsequent task performance (the Mozart effect); (2) music instruction; and (3) background music listening. Research suggests that while Mozart effect studies have attracted considerable media attention, the effect cannot be reliably demonstrated in children. In contrast, music instruction confers consistent benefits for spatiotemporal reasoning skills; however, improvements in associated academic domains, such as arithmetic, have not been reliably shown. Finally, background music may calm and focus children with special education needs, thereby enhancing learning. Additional research is required to determine whether this effect is evident in normal populations. Overall, evidence for the non-musical benefits of music listening and instruction is limited. The inherent value of music and music education should not be overlooked by narrowly focusing on cognitive and academic outcomes.

Over the past decade there has been increasing speculation about the potential cognitive and academic benefits of music for children's development. This speculation has stirred interest among parents, educators, and politicians alike, and has precipitated a large industry of musical products targeted at infants and children. Claims about the non-musical benefits of music do not stem from a single field of research, or from research domains with a coherent theoretical basis. Rather, such claims have emerged from at least three distinct, empirically-driven research areas that have examined the non-musical sequelae of: (1) focused listening to certain types of complex music (the Mozart effect); (2) music lessons; and (3) background classroom music. Evidence from each of these domains is considered in this paper,

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and comments are made on the resultant cognitive, academic, and educational implications.

The Mozart Effect

Proponents for the Mozart effect claim that performance on tasks of spatiotemporal reasoning may be improved for 10–15-minutes immediately after listening to part of a Mozart piano sonata (K. 448) or similar complex music (Rauscher & Shaw, 1998; Rauscher, Shaw, & Ky, 1993). Spatiotemporal reasoning involves the sequential processing of spatial information over time. It forms part of the broader cognitive domain of visuo-spatial function (Linn & Peterson, 1986). In typical Mozart effect studies participants listen to the first movement of K. 448, which lasts for approximately eight and a half minutes, and then complete a paper and pencil spatiotemporal task. The vast majority of studies have used the paper folding and cutting subtest of the Stanford-Binet Intelligence Scale Fourth Edition (Thorndike, Hagen, & Sattler, 1986) or an equivalent task (cf. Hetland, 2000b). The Mozart effect has not been demonstrated using other outcome measures, making the effect highly task dependent (Chabris, 1999). Given that spatiotemporal reasoning may be relevant to success in subjects such as mathematics and science (Cooper & Mumaw, 1985), it has been purported that the Mozart effect may have significant educational implications (e.g., Shaw, 2000).

Research investigating the Mozart effect has typically been conducted with adults and has yielded equivocal findings. Two meta-analyses of the adult literature have been performed; these employed the statistic d , which is the difference between treatment and control means, divided by their pooled standard deviation (Richardson, 1996). Chabris (1999) analysed 12 experiments involving 522 participants, and found the Mozart effect was non-significant and unreliable with a small effect size ($d = .14$). In contrast, Hetland (2000b) found a medium-sized effect (weighted $d = .39$) in an analysis of 31 experiments involving 2,089 participants. Hetland's analysis included 12 unpublished studies, many of which reported a large Mozart effect, leading to significant heterogeneity in the sample of effect sizes and raising concerns about the summary data (Steele, 2003). Moreover, many of the adult studies, including the original reports of Rauscher et al. (1993, 1995), have methodological limitations (Fudin & Lembessis, 2004). Studies that are well-controlled have tended to report non-significant findings (e.g., Steele, Bass, & Crook, 1999; Steele, Dalla Bella, et al., 1999), or have shown that the Mozart effect is an artefact of improved arousal and mood (Husain, Thompson, & Schellenberg, 2002; Thompson, Schellenberg, & Husain, 2001). In light of these issues, the original claims that Mozart's music primes or "resonates" with the brain (Leng & Shaw, 1991; Rauscher et al., 1995) appear tenuous.

Four studies have directly examined the Mozart effect in children (Črnčec, Wilson, & Prior, in press; Hallam, 2000; Ivanov & Geake, 2003; McKelvie & Low, 2002). Hallam (2000) found no evidence for the Mozart effect in a naturalistic school environment using a sample of 8,120 children 10–11 years of age. McKelvie

and Low (2002) conducted two studies of the Mozart effect in 103 children aged approximately 12 years. They did not observe a Mozart effect, and reported that neither participant preference for the experimental stimuli nor prior music training affected the results. Crnčec et al. (in press) reported no evidence of a Mozart effect in a sample of 136 children aged 9–11 years. This study employed a counterbalanced within-subjects design. Participants reported improved mood and arousal following exposure to popular music compared with Mozart K. 448 or silence, but this did not confer an advantage to spatiotemporal performance. In contrast, Ivanov and Geake (2003) reported a small Mozart effect in 76 children aged 10–12 years. These results are difficult to interpret, however, because the study required children to listen to music continuously while performing a spatiotemporal task, significantly changing the experimental paradigm from other Mozart effect studies. Ivanov and Geake's (2003) findings may be better placed with studies examining the influence of background music (reviewed below). Thus, at present there is no strong evidence for a Mozart effect in children.

Given the weak empirical support for the Mozart effect generally, and the lack of positive findings in children in particular, continuing popular enthusiasm for the Mozart effect is surprising. Several factors may explain this. First, the results of the original Mozart effect experiment (Rauscher et al., 1993) were widely reported in the popular press as evidence that “Mozart makes you smarter” (e.g., NBC News, 1994). Schellenberg (2001) has suggested that this may be the most widespread popular misconception of any psychological finding. Second, the term “Mozart effect” has been trademarked by Campbell to signify the proposed wide-ranging benefits of music in improving health, creativity, and intellectual abilities (Campbell, 1997). While Campbell's books and compact discs are promoted under the term “Mozart effect” his work is not specifically based on any of the scientific research outlined above. Finally, the term “Mozart effect” has been applied to a wide range of findings, including the proposed benefits of Mozart in the treatment of epilepsy (Hughes, Daaboul, Fino, & Shaw, 1998) and rodent maze learning (Rauscher, Robinson, & Jens, 1998). Together, these factors have generated considerable confusion regarding the nature of the Mozart effect, and created a misleading impression about its breadth and robustness (cf. Bangerter & Heath, 2004).

Non-Musical Benefits of Music Lessons

Correlational Research

Speculation about the benefits of musical training on broader academic achievement is not new (e.g., Earhart, 1920). Early speculation largely stemmed from anecdotal observations that above average musical abilities in children and adults frequently co-occurred with above average abilities in other academic domains. Thus, it was reasoned that music training, through improving musical ability, might also improve other cognitive functions.

Many correlational studies have reported a modest association between musical ability and non-musical skills, including spatial ability (e.g., Barret & Barker, 1973; Hassler, Birbaumer, & Feil, 1985; Karma, 1979; Manturzewska, 1978; Nelson & Barressi, 1989), literacy (Anvari, Trainor, Woodside, & Levy, 2002; Bultzlaff, 2000), and general intelligence (Lynn, Wilson, & Gault, 1989). An association, however, cannot be taken as evidence of causality. Causal claims can only be made on the basis of experimental research, which is reviewed below. It is worth noting that correlations similar to those found between musical ability and other cognitive and academic abilities have also been observed for many forms of arts training (for a review see Winner & Cooper, 2000), suggesting that moderating variables, such as socioeconomic status or familial attitudes to learning, might underpin these associations.

Music Lessons and Spatial Ability

Hetland (2000a) performed a meta-analysis of experimental studies examining the effects of music lessons on spatiotemporal and other abilities. Her main analysis included 15 studies (nine of which were unpublished) involving 701 children aged 3–12 years undergoing music lessons in programs ranging in duration from four weeks to two years. Hetland reported a mean effect size of $r = .29$ for improved spatiotemporal abilities following lessons on the basis of the published literature, and $r = .44$ for the unpublished studies. The combined mean effect size, weighted according to the number of participants in each study, was $r = .39$. The effect size r is a measure of association, or correlation, between two variables – in this case between exposure to music lessons and performance on cognitive tasks (cf. Richardson, 1996). Cohen (1992) suggested that r values of .1, .3, and .5 reflected small, medium, and large effect sizes respectively. Thus, there appears to be a medium to large effect of music lessons on spatiotemporal ability. Hetland also analysed the effects of music lessons on a broader range of spatial abilities, including “spatial memory, spatial recognition, mental rotation, and/or spatial visualization” (p. 218). The mean weighted effect size for these nine studies ($n = 655$) was $r = .20$. Due to the variety of tasks included in the analysis and the small number of studies, Hetland (2000a) cautioned that this result should be considered equivocal until research replicates the effects. It is interesting to note that in a third meta-analysis of five studies ($n = 694$) examining Raven’s progressive matrices, Hetland found no benefit of music lessons (weighted mean $r = .03$). This task is principally a non-verbal measure of logical reasoning (Carpenter, Just, & Shell, 1990). Thus, any benefits of music lessons may be confined to spatiotemporal tasks.

Hetland (2000a) performed several planned contrasts on the data pertaining to music lessons and spatiotemporal ability. She concluded that: (1) active music lessons appear to enhance spatiotemporal performance in children while instruction is occurring and that this enhancement continues for at least two years of instruction; (2) this benefit occurs with any type or style of instruction, although individual lessons produce a somewhat larger effect than group lessons ($r = .48$ and $r = .32$ respectively); (3) the enhancement of spatiotemporal skills is more likely to occur

when music instruction is offered to younger children (3–5 years); and (4) instruction in standard musical notation may give rise to additional improvements in spatiotemporal function (Hetland, 2000a). Hetland offered several caveats to the interpretation of these results. Principal among these was the possibility that enhanced spatiotemporal performance may not continue after two years of instruction (e.g., Costa-Giomi, 1999). In other words, music instruction may provide a relatively short-lived developmental advantage.

Recently, several studies have built upon Hetland's (2000a) main finding that music instruction improves spatiotemporal ability (Bilhartz, Bruhn, & Olson, 2000; Rauscher, 2002; Rauscher & LeMieux, 2003), and have provided further evidence that instruction commencing before the age of five may be associated with larger effects.

Music Lessons and Mathematics

Given the proposed links between spatiotemporal skills and mathematics (Cooper & Mumaw, 1985), several experimental studies have examined whether music instruction leads to improved performance on tests of arithmetic. Vaughn (2000) performed a meta-analysis of six studies that examined this hypothesis (three studies were unpublished), involving a total of 357 participants aged 3–12 years. The resulting mean effect size for the published studies was $r = .10$, and the weighted mean effect size across all studies was $r = .16$. In contrast to Hetland (2000a), Vaughn (2000) reported that studies including instruction in standard notation were not associated with better mathematics performance than those without instruction. Vaughn cautioned that further replication of the findings was required before the results could be considered conclusive, noting that of the six studies, three showed an effect while three did not. A more recent study has found that economically disadvantaged children who had two years of musical training performed better than controls on tests of arithmetic (Rauscher & LeMieux, 2003). In contrast, a longitudinal study involving 117 Grade 4 children found that three years of weekly, individual piano lessons did not affect arithmetic performance (Costa-Giomi, 2004). Further studies are required before any effect of music lessons on arithmetical ability can be determined.

Music Lessons and Reading

Bultzlaff (2000) reported a meta-analysis of six experimental studies (three of which were unpublished) that evaluated the effects of music lessons on reading acquisition in a total of 187 children. The resulting weighted mean effect size was $r = .11$, which is low. Bultzlaff (2000) concluded that due to the large heterogeneity in effect sizes, this result is not reliable. He also suggested that the large positive results found in some studies (e.g., Douglas & Willatts, 1994; Fetzer, 1994) may have resulted from non-random assignment of participants to groups and poor control of experimenter expectancy effects. A more recent study has demonstrated a link between music

lessons and verbal memory performance (Ho, Cheung, & Chan, 2003), which may have implications for reading ability. This result, however, requires replication, and the relationship between reading ability and verbal memory function needs to be carefully explicated. Thus, there is presently little evidence to support a link between musical training and reading acquisition.

Music Lessons and IQ

Motivated by the possibility that the diverse range of purported non-musical effects of music instruction are related to a common underlying benefit, Schellenberg (2004) evaluated the hypothesis that music lessons increase general intelligence. Participants were 132 six-year-old children, who were randomly assigned to one of four groups: standard keyboard lessons, Kodaly voice lessons, drama lessons, or no lessons. The lessons were conducted in groups of six, for a period of 36 weeks. Participants were administered the Wechsler Intelligence Scale for Children Third Edition (WISC-III; Wechsler, 1991) prior to the commencement of lessons and again 12 months later. Schellenberg reported that the IQ of all groups improved from pre- to post-test. He also noted that the combined musical groups had a significantly larger improvement (7 IQ points) than participants assigned to drama lessons and no lessons (4.3 IQ points). The effect was of small to medium size ($d = .35$). In contrast, parent-rated measures of adaptive behaviour increased from pre- to post-test for the drama lessons group only.

Given that attendance at school raises IQ (Ceci & Williams, 1997), and that music lessons were essentially school-like, Schellenberg (2004) reasoned that music lessons may improve IQ by providing participants with additional educational experiences.

It should be noted, however, that the drama lessons group showed a similar pre- to post-test improvement to the standard keyboard training group (5.1 versus 6.1 IQ points respectively). Thus, Schellenberg's conclusion that "drama instruction is not an extracurricular activity associated with notable increases in intellectual development" (p. 512) may not be entirely accurate. Moreover, meta-analysis of available research suggests that drama instruction is associated with improvements in verbal domains such as story understanding (cf. Podlozny, 2000).

Given that this is the first study to examine associations between musical instruction and IQ using a longitudinal design, any effects need to be replicated and shown to be durable before the results could be considered definitive.

Implications

In many respects the importance one assigns to this body of research depends, in part, on the theoretical framework on which the findings are based. Two types of theories predominate: neuroscientific and near transfer theories. The most widely cited neuroscientific theory is the trion model (Leng & Shaw, 1991). This model posits that music "resonates" with inherent neuronal firing patterns throughout the brain; thus, music listening and instruction can "prime" the brain for improved

performance on spatiotemporal and other cognitive tasks. Recently, increasing support has been accorded to near transfer theories (Rauscher, 2002; Schellenberg, 2001), which contend that musical instruction and spatiotemporal reasoning tasks require related cognitive skills. Learning that occurs during music instruction, therefore, may transfer to other tasks. For example, learning to read musical notation and understand spatial relations on the keyboard requires visuo-spatial skills. Practising these abilities may lead to improved visuo-spatial abilities in other contexts, such as paper folding and cutting tasks.

The trion model and related neuroscientific theories imply that there is something special or unique about the interaction between music and the functioning of the brain, while transfer theories can apply to many types of learning and cognitive domains. In other words, near transfer theories stop short of suggesting that music lessons may be the only way, or a particularly efficient way, of enhancing spatiotemporal skills (Salomon & Perkins, 1989). In this context, studies examining the non-musical benefits of musical instruction have failed to examine the extent to which a given skill could be improved by additional direct instruction. For example, music instruction has not been directly compared with extracurricular training in arithmetic or reading. Only one study (Graziano, Peterson, & Shaw, 1999) has partly addressed this issue, testing 136 children aged between six to eight years who were each assigned to one of three groups: keyboard training and spatiotemporal skills training (ST), English lessons and ST, and no lessons. Graziano et al. found that the keyboard-ST and English-ST groups outperformed the no lessons group on a test of arithmetic, while the keyboard-ST group showed a 15% advantage over the English-ST group. In this study, however, there was no group that received additional training in arithmetic, making it difficult to evaluate the significance of these results fully.

The possibility that music instruction has far transfer effects to domains not specifically taught, such as general IQ (Schellenberg, 2004), is fascinating. Schellenberg (2001) has suggested that music instruction consists of a particular combination of factors, such as hours of individual practice, attention, and concentration, that could lead to a far transfer of learning strategies and motivation. Evidence to date, however, does not support the notion that music lessons offer any advantage over and above other extracurricular education involving focused activity that a child may enjoy. The emphasis on music and music lessons in the past decade may have done something of an injustice to the other arts, which may also elicit modest near and far transfer effects.

Background Music in Classrooms

Researchers have long been interested in the possibility that background classroom music may enhance learning outcomes (e.g., Mitchell, 1949). Typical studies employ soothing music, based on the underlying hypothesis that such music may cause optimal arousal for learning. Normal population studies in this area have produced mixed results. For example, some studies have reported enhanced reading

comprehension with background music (Hall, 1952; Mitchell, 1949), while others have reported no effect (Fogelson, 1973; Kiger, 1989). Research has also indicated that background music does not enhance test performance (Henderson, Crews, & Barlow, 1945; Mowesian & Heyer, 1973).

A meta-analysis of 13 studies involving 357 participants concluded that background music was not associated with improved arithmetic performance (weighted $r = .06$; Vaughn, 2000). Recent studies, however, have produced more positive results. Hallam, Price, and Katsarou (2002) compared arithmetic performance during silence and calming background music in 31 children aged 11–12 years using a within-subjects design. The results showed that the music condition was associated with greater completion of arithmetic problems, although overall accuracy was not improved. The authors proposed that this finding may reflect reduced arousal associated with music. In support of this, they also demonstrated that background music perceived by children as arousing and aggressive impaired performance on a memory task, and reduced scores on a measure of altruism (Hallam et al., 2002).

Hallam et al. (2002) proposed that soothing music might be a useful classroom tool when normally developing children are over-aroused, such as after lunchtime breaks. Conversely, lively music could be used to increase arousal when children are under-stimulated. Chalmers, Olson, and Zurkowski (1999) have provided some support for these claims by demonstrating that soothing music played in school lunchrooms may reduce noise levels and behavioural problems during breaks. While these claims need to be replicated, they concur with adult findings that different types of music affect mood and arousal differently (e.g., Gabrielsson & Lindstrom, 2001; Krumhansl, 1997; Peretz, 2001; Schmidt & Trainor, 2001; Sloboda & Juslin, 2001; Thayer & Levenson, 1983; Westerman, Spies, Stahl, & Hesse, 1996), and that background music can affect many aspects of behaviour, such as product choice and preferences for different environments (for a review see Hargreaves & North, 1997b).

Isen (2000, 2002) and others have indicated that positive mood may facilitate cognitive task performance and altruism, while negative mood can disrupt performance (O'Hanlon, 1981). This means that music played to children should be enjoyable to achieve maximum benefits (Giles, 1991). In this context, it is unlikely that background music directly improves children's cognitive abilities *per se*. The arousal-mood model of the Mozart effect in adults (Husain et al., 2002; Thompson et al., 2001) is relevant to this discussion, except that in most situations presently investigated, it would appear that the ideal music to play to children should reduce arousal and induce positive mood. Unfortunately, studies to date have not clearly operationalised descriptive terms such as "calming" and "soothing", nor have they specified which characteristics of the musical stimuli may be most pertinent.

Hargreaves and colleagues have examined the musical preferences of school-age children and adolescents, and the important roles that music can play in their lives (Hargreaves, Comber, & Colley, 1995; Hargreaves & North, 1997a; Lamont, Hargreaves, Marshall, & Tarrant, 2003; North, Hargreaves, & O'Neill, 2000). Their findings may be especially relevant for the selection of appropriate background

music for children of different ages. Future research should address individual differences in response to music, as there may be a proportion of students who do not benefit from, or who are disadvantaged by, background music.

Studies examining the use of soothing background music in special education populations have generally shown positive results. For example, such music has been shown to: (1) decrease the activity of children suffering hyperactivity (Cripe, 1986; Scott, 1970) or intellectual disability (Gregoire, 1984; Reardon & Bell, 1970); (2) improve concentration (Savan, 1999) and arithmetic performance (Hallam & Price, 1998) in children experiencing emotional, behavioural, and learning difficulties; and (3) improve the representational art-work of children who have severe intellectual disability (Riddoch & Waugh, 2003). Savan (1998, 1999) has demonstrated that soothing music reduces physiological markers of arousal such as blood pressure, body temperature, and heart rate in special needs children. High arousal and stress are known to induce physiological sequelae such as raised corticosteroid and adrenaline levels, which can hinder learning (Smith, 1996). Since special needs children may experience high baseline stress and arousal due to their academic and personal difficulties, reduced arousal associated with soothing music may underpin improved outcomes (Savan, 1999). Further systematic research is strongly indicated in this area, including an examination of whether the beneficial effects of soothing music persist over time. Music therapy techniques, including the structured use of music experiences to reduce arousal, could be incorporated into future studies (cf. Davidson & Edwards, 1998; Heal & Wigram, 1993).

General Summary

The present paper has examined evidence from three fields of experimental research relevant to the question of whether music listening and instruction can improve non-musical cognitive and academic abilities in children. The main findings can be summarised as follows:

1. The Mozart effect does not appear to be demonstrable in children, and the unreliability of results in adults casts serious doubts over the general validity of this effect. Hence, there arise no direct educational implications from this specific area of research.
2. With regard to music lessons, the only robust finding is a small improvement in spatiotemporal reasoning. This improvement does not routinely translate into academic benefits, although some studies have reported this. At this stage, a plausible explanation for this spatiotemporal improvement is near transfer. It is likely, however, that providing direct additional instruction in academic skills, particularly in a one-to-one context (cf. Bloom, 1984), may be more beneficial than music lessons.
3. Background classroom music cannot be reliably shown to enhance children's cognitive and academic performance. In contrast, soothing background music in

special education settings appears to be effective in focusing children and reducing arousal. Further research is needed to determine whether this effect can be reliably demonstrated in normal populations. It should also be noted that other factors will exert important and more direct influences on educational outcomes, including class sizes and teacher expertise (Ehrenberg, Brewer, Gamoran, & Wilms, 2001).

Concluding Discussion

Several general issues are pertinent to the literature summarised in this paper. First, the position of music in school curricula has been increasingly uncertain over recent decades throughout the Western world (Duke, 2000; Reimer, 1999). The literature examined here may have held some appeal to interested parties, in that it suggests music listening and exposure can produce additional non-musical benefits, thereby helping to justify the inclusion of music in the curriculum. It is important to uncouple these issues, however, to avoid the conclusion that if music cannot produce significant non-musical cognitive benefits, then it is of limited value in education. On the contrary, musical education can broaden and enrich a child's development in many ways. In particular, music has an intrinsic value as a great cultural invention, it has the ability to function as a vehicle for emotional expression and communication (Reimer, 1999; Trevarthen & Malloch, 2002), and is a positive activity that can be participated in by children of all cultures, ages, and abilities. The experience of enjoyment in and developing mastery of music is likely to influence positively a child's developing orientation to tasks requiring persistence (cf. Turner & Johnson, 2003). Indeed, Costa-Giomi (2004) reported that the self-esteem of children receiving three years of piano instruction improved significantly compared to children not receiving instruction. Furthermore, music lessons and other arts training may help to create a stimulating and motivating academic environment that is conducive to wider learning. Such multifactorial effects are difficult to examine scientifically, but warrant systematic exploration.

Second, speculation that findings such as the Mozart effect will form useful early intervention strategies to improve children's cognitive development may have drawn attention and resources away from programs and policies that have already been shown to be effective, as well as hindering the development of future programs. The early intervention literature has shown that when colourful but simplistic solutions like the Mozart effect inevitably fail, momentum in the area of early interventions can be lost (Jones & Zigler, 2002). Evidence compiled over the past 40 years of early intervention research does not support sustained developmental gains after short-term interventions: There are no quick fixes or panaceas (Jones & Zigler, 2002). Conversely, programs that are comprehensive, of high quality, and of sufficient duration and intensity can have a positive impact on the health and development of children (Baker & Feinfeld, 2003). This is particularly true for children who are living in deprived conditions and/or who are at risk for developmental problems (Olds et al., 1997; Reynolds, 2000).

Third, the narrow focus on children's cognitive development inherent in the literature serves to exclude other important domains, including socioemotional and physical development. This broader view acknowledges that intellectual development is intricately linked to the child's other attributes and the environment (Zigler & Styfco, 1993). Physical and psychosocial health are necessary ingredients for effective learning and cognitive development in all children (Stoep, Weiss, Kuo, Cheney, & Cohen, 2003), and children who do not have emotional stability and security within their environment can be compromised in their ability to learn. Thus, those interested in improving the cognitive and academic performance of children need to embrace the difficult task of addressing these broader issues where applicable.

Fourth, the finding that exposure to a musical environment may be crucial to infant development should be emphasised (Trevvarthen, 2001). Research has demonstrated that infants and toddlers seek and initiate musical interactions with caregivers and objects in their environments (Custodero, 2002). Maternal singing captures infant attention better than maternal speech (Trehub, 2002), and infants prefer the musical qualities of infant-directed speech to adult-directed speech (Cooper & Aslin, 1990; Werker & McLeod, 1989). The use of music can vary according to the infant's level of development, first to calm and arouse, and then to provide an opportunity for performance and singing. Young children can explore movement, emotions, and thoughts with others or alone using music (Trevvarthen & Malloch, 2002). Furthermore, some researchers have suggested that music may have served an evolutionary purpose in helping parents bond with, and regulate the emotions of, their infants (Trehub, 2002).

In conclusion, the core value and importance of music lies in musical ends, for example learning to play an instrument and gaining meaningful musical experiences (cf. Reimer, 1999). The absence of convincing non-musical cognitive and academic benefits of music listening or instruction does nothing to reduce this value.

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References

- Anvari, S. H., Trainor, L. J., Woodside, J., & Levy, B. A. (2002). Relations among musical skills, phonological processing and early reading ability in preschool children. *Journal of Experimental Child Psychology*, 83, 111–130.
- Baker, B. L., & Feinfield, K. A. (2003). Early intervention. *Current Opinion in Psychiatry*, 16, 503–509.
- Bangerter, A., & Heath, C. (2004). The Mozart effect: Tracking the evolution of a scientific legend. *British Journal of Social Psychology*, 43, 605–623.
- Barret, H. C., & Barker, H. R., Jr. (1973). Cognitive pattern perception and musical performance. *Perceptual and Motor Skills*, 36, 1187–1193.

- Bilhartz, T. D., Bruhn, R. A., & Olson, J. E. (2000). The effect of early music training on child cognitive development. *Journal of Applied Developmental Psychology, 20*, 615–636.
- Bloom, B. S. (1984). The 2 sigma problem: The search for methods of group instruction as effective as one-to-one tutoring. *Educational Researcher, 13*(6), 4–16.
- Bultzlaff, R. (2000). Can music be used to teach reading? *Journal of Aesthetic Education, 34*, 179–238.
- Campbell, D. (1997). *The Mozart effect: Using the power of music to heal the body, strengthen the mind and unlock the creative spirit*. New York: Avon Books.
- Carpenter, P. A., Just, M. A., & Shell, P. (1990). What one intelligence test measures: A theoretical account of the processing in the Raven progressive matrices test. *Psychological Review, 97*, 404–431.
- Ceci, S. J., & Williams, W. M. (1997). Schooling, intelligence and income. *American Psychologist, 52*, 1051–1058.
- Chabris, C. F. (1999). Prelude or requiem for the ‘Mozart effect’? *Nature, 402*, 826–827.
- Chalmers, L., Olson, M. R., & Zurkowski, J. K. (1999). Music as a classroom tool. *Intervention in School and Clinic, 35*, 43–45.
- Cohen, J. (1992). A power primer. *Quantitative Methods in Psychology, 112*, 155–159.
- Cooper, L. A., & Mumaw, R. (1985). Human spatial aptitude. In R. Schmitt (Ed.), *Individual differences in cognitive processes (Vol. 2, pp. 67–94)*. New York: Academic Press.
- Cooper, R. P., & Aslin, R. N. (1990). Preference for infant-directed speech in the first month after birth. *Child Development, 61*, 1584–1595.
- Costa-Giomi, E. (1999). The effects of three years of piano instruction on children’s cognitive development. *Journal of Research in Music Education, 47*, 198–212.
- Costa-Giomi, E. (2004). Effects of three years of piano instruction on children’s academic achievement, school performance and self-esteem. *Psychology of Music, 32*, 139–152.
- Cripe, F. F. (1986). Rock music as therapy for children with attention deficit disorder: An exploratory study. *Journal of Music Therapy, 23*, 30–37.
- Črnčec, R., Wilson, S. J., & Prior, M. (in press). No evidence for the Mozart effect in children. *Music Perception*.
- Custodero, L. A. (2002). The musical lives of young children: Inviting, seeking, and initiating. *Zero to Three, 25*, 4–9.
- Davidson, D., & Edwards, J. (1998). *A role for music therapy in special education*. Brisbane: Carfax.
- Douglas, S., & Willatts, P. (1994). The relationship between musical ability and literacy skills. *Journal of Research in Reading, 17*, 99–107.
- Duke, R. A. (2000). The other Mozart effect: An open letter to music educators. *Applications of Research in Music Education, 19*, 9–16.
- Earhart, W. (1920). The value of applied music as a school subject. In K. Gehrken (Ed.), *Papers and Proceedings of the Music Teachers National Association Forty-First Annual Meeting* (pp. 163–170). Hartford, CT: Music Teacher National Association.
- Ehrenberg, R. G., Brewer, D. J., Gamoran, A., & Wilms, J. D. (2001). Class size and student achievement. *Psychological Science in the Public Interest, 2*, 1–30.
- Fetzer, L. (1994). *Facilitating print awareness and literacy development with familiar children’s songs*. Unpublished doctoral dissertation, East Texas University.
- Fogelson, S. (1973). Music as a distracter on reading-test performance of eighth grade students. *Perceptual and Motor Skills, 36*, 1265–1266.
- Fudin, R., & Lembessis, E. (2004). The Mozart effect: Questions about the seminal findings of Rauscher, Shaw, and colleagues. *Perceptual and Motor Skills, 98*, 389–405.
- Gabrielsson, A., & Lindstrom, E. (2001). The influence of musical structure on emotional expression. In J. A. Sloboda (Ed.), *Music and emotion: Theory and research* (pp. 223–248). New York: Oxford University Press.
- Giles, M. (1991, November). A little background music please. *Principal, 451–458*.

- Graziano, A. B., Peterson, M., & Shaw, G. L. (1999). Enhanced learning of proportional math through music training and spatial-temporal reasoning. *Neurological Research, 21*, 139–152.
- Gregoire, M. A. (1984). Music as a prior condition to task performance. *Journal of Music Therapy, 21*, 133–145.
- Hall, J. (1952). The effect of background music on the reading comprehension of 278 eighth and ninth grade students. *Journal of Educational Research, 45*, 451–458.
- Hallam, S. (2000). The effects of listening to music on children's spatial task performance. *British Psychological Society Education Review, 25*(2), 22–26.
- Hallam, S., & Price, J. (1998). Can the use of background music improve the behaviour and academic performance of children with emotional and behavioural difficulties? *British Journal of Special Education, 25*(2), 87–90.
- Hallam, S., Price, J., & Katsarou, G. (2002). The effects of background music on primary school pupils' task performance. *Educational Studies, 28*, 111–122.
- Hargreaves, D. J., Comber, C., & Colley, A. (1995). Effects of age, gender, and training on musical preferences of British secondary school students. *Journal of Research in Music Education, 43*, 242–250.
- Hargreaves, D. J., & North, A. C. (1997a, March). *The development of musical preference across the life span*. Paper presented at the Annual Meeting of the American Educational Research Association, Chicago IL.
- Hargreaves, D. J., & North, A. C. (Eds.). (1997b). *The social psychology of music*. Oxford, UK: Oxford University Press.
- Hassler, M., Birbaumer, N., & Feil, A. (1985). Musical talent and visuo-spatial ability: A longitudinal study. *Psychology of Music, 13*, 99–113.
- Heal, M., & Wigram, T. (Eds.). (1993). *Music therapy in health and education*. London: Jessica Kingsley.
- Henderson, M. T., Crews, A., & Barlow, J. (1945). A study of the effect of music distraction on reading efficiency. *Journal of Applied Psychology, 29*, 313–317.
- Hetland, L. (2000a). Learning to make music enhances spatial reasoning. *Journal of Aesthetic Education, 34*, 179–238.
- Hetland, L. (2000b). Listening to music enhances spatial-temporal reasoning: Evidence for the "Mozart effect". *Journal of Aesthetic Education, 34*, 105–148.
- Ho, Y. C., Cheung, M. C., & Chan, A. S. (2003). Music training improves verbal but not visual memory: Cross sectional and longitudinal explorations in children. *Neuropsychology, 17*, 439–450.
- Hughes, J. R., Daaboul, Y., Fino, J. J., & Shaw, G. L. (1998). The Mozart effect on epileptiform activity. *Clinical Electroencephalography, 29*, 109–119.
- Husain, G., Thompson, W. F., & Schellenberg, E. G. (2002). Effects of musical tempo and mode on arousal, mood, and spatial abilities. *Music Perception, 20*, 151–171.
- Isen, A. M. (2000). Positive affect and decision making. In J. Haviland-Jones (Ed.), *Handbook of emotions* (2nd ed., pp. 417–435). New York: Guilford.
- Isen, A. M. (2002). A role for neuropsychology in understanding the facilitating influence of positive affect on social behaviour and cognitive processes. In C. R. Snyder & S. J. Lopez (Eds.), *Handbook of positive psychology* (pp. 528–540). New York: Oxford University Press.
- Ivanov, V. K., & Geake, J. G. (2003). The Mozart effect and primary school children. *Psychology of Music, 31*, 405–413.
- Jones, S. M., & Zigler, E. (2002). The Mozart effect not learning from history. *Applied Developmental Psychology, 23*, 355–372.
- Karma, K. (1979). Musical, spatial and verbal abilities. *Bulletin of the Council for Research in Music Education, 59*, 50–53.
- Kiger, D. M. (1989). Effects of music information load on a reading comprehension task. *Perceptual and Motor Skills, 69*, 531–534.

- Krumhansl, C. L. (1997). An exploratory study of musical emotions and psychophysiology. *Canadian Journal of Experimental Psychology*, 51, 336–352.
- Lamont, A., Hargreaves, D. J., Marshall, N. A., & Tarrant, M. (2003). Young people's music in and out of school. *British Journal of Music Education*, 20, 229–241.
- Leng, X., & Shaw, G. L. (1991). Towards a neural theory of higher brain function using music as a window. *Concepts in Neuroscience*, 2, 229–258.
- Linn, M. C., & Peterson, A. C. (1986). A meta-analysis of gender differences in spatial ability: Implications for mathematics and science achievement. In J. S. Hyde & M. C. Linn (Eds), *The psychology of gender: Advances through meta-analysis* (pp. 67–99). Baltimore, MD: Johns Hopkins University Press.
- Lynn, R., Wilson, R. G., & Gault, A. (1989). Simple musical tests as measures of Spearman's g . *Personality and Individual Differences*, 10, 25–28.
- Manturzewska, M. (1978). Psychology in the music school. *Psychology of Music*, 6(2), 36–47.
- McKelvie, P., & Low, J. (2002). Listening to Mozart does not improve children's spatial ability: Final curtains for the Mozart effect. *British Journal of Developmental Psychology*, 20, 241–258.
- Mitchell, A. H. (1949). The effect of radio programs on silent reading achievement of ninety-one sixth grade students. *Journal of Educational Research*, 42, 460–470.
- Mowesian, R., & Heyer, M. R. (1973). The effect of music as a distraction on test-taking performance. *Measurement and Evaluation in Guidance*, 6, 104–110.
- NBC News (Writer). (1994). *Dateline NBC*. Livingston, NJ: Burrelle's Information Services.
- Nelson, D. J., & Barressi, A. L. (1989). Children's age-related intellectual strategies for dealing with musical and spatial analogical tasks. *Journal of Research in Music Education*, 37, 93–103.
- North, A. C., Hargreaves, D. J., & O'Neill, S. A. (2000). The importance of music to adolescents. *British Journal of Educational Psychology*, 70, 255–272.
- O'Hanlon, J. F. (1981). Boredom: Practical consequences and a theory. *Acta Psychologica*, 49, 53–82.
- Olds, D. L. et al. (1997). Long-term effects of home visitation on maternal life-course and child abuse and neglect. *Journal of the American Medical Association*, 27.
- Peretz, I. (2001). Listen to the brain: A biological perspective on musical emotions. In J. A. Sloboda (Ed.), *Music and emotion: Theory and research* (pp. 105–134). New York: Oxford University Press.
- Podlozny, A. (2000). Strengthening verbal skills through the use of classroom drama: A clear link. *Journal of Aesthetic Education*, 34, 239–275.
- Rauscher, F. H. (2002). Mozart and the mind: Factual and fictional effects of musical enrichment. In J. Aronsen (Ed.), *Improving academic achievement: Impact of psychological factors on education* (pp. 267–278). San Diego, CA: Academic Press.
- Rauscher, F. H., & LeMieux, M. T. (2003, March). *Piano, rhythm, and singing instruction improve different aspects of spatial-temporal reasoning in Head Start children*. Poster presented at the Annual Meeting of the Cognitive Neuroscience Society, New York.
- Rauscher, F. H., Robinson, K. D., & Jens, J. J. (1998). Improved maze learning through early music exposure in rats. *Neurological Research*, 20, 427–432.
- Rauscher, F. H., & Shaw, G. L. (1998). Key components of the Mozart effect. *Perceptual and Motor Skills*, 86, 835–841.
- Rauscher, F. H., Shaw, G. L., & Ky, K. N. (1993). Music and spatial task performance. *Nature*, 365(6447), 611.
- 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.
- Reardon, D., & Bell, G. (1970). Effects of sedative and stimulative music on activity levels of severely retarded boys. *American Journal of Mental Deficiency*, 75, 156–159.
- Reimer, B. (1999). Facing the risks of the "Mozart effect". *Music Educators Journal*, 86(1), 37–43.
- Reynolds, A. (2000). *Success in early intervention: The Chicago parent-child centers*. Lincoln, NE: University of Nebraska Press.

- Richardson, J. T. E. (1996). Measures of effect size. *Behavior Research Methods, Instruments, and Computers*, 28, 12–22.
- Riddoch, J. V., & Waugh, R. F. (2003). Teaching students with severe intellectual disabilities non-representational art using a new pictorial and music programme. *Journal of Intellectual and Developmental Disability*, 28, 145–162.
- Salomon, G., & Perkins, D. N. (1989). Rocky roads to transfer: Rethinking mechanisms of a neglected phenomenon. *Educational Psychologist*, 24, 113–142.
- Savan, A. (1998). A study of the effect of background music on the behaviour and physiological responses of children with special educational needs. *The Psychology of Education Review*, 22, 32–36.
- Savan, A. (1999). The effect of background music on learning. *Psychology of Music*, 27, 138–146.
- Schellenberg, E. G. (2001). Music and nonmusical abilities. *Annals of the New York Academy of Sciences*, 930, 355–371.
- Schellenberg, E. G. (2004). Music lessons enhance IQ. *Psychological Science*, 15, 511–514.
- Schmidt, L. A., & Trainor, L. J. (2001). Frontal brain electrical activity (EEG) distinguishes valence and intensity of musical emotions. *Cognition and Emotion*, 15, 487–500.
- Scott, T. (1970). The use of music to reduce hyperactivity in children. *American Journal of Orthopsychiatry*, 4, 677–680.
- Shaw, G. L. (2000). *Keeping Mozart in mind*. San Diego, CA: Academic Press.
- Sloboda, J. A., & Juslin, P. N. (2001). Psychological perspectives on music and emotion. In J. A. Sloboda (Ed.), *Music and emotion: Theory and research* (pp. 71–104). New York: Oxford University Press.
- Smith, A. (1996). *Accelerated learning in the classroom*. Stafford, UK: Network.
- Steele, K. M. (2003). Do rats show a Mozart effect? *Music Perception*, 21, 251–265.
- Steele, K. M., Bass, K. E., & Crook, M. D. (1999). The mystery of the Mozart effect: Failure to replicate. *Psychological Science*, 10, 366–369.
- Steele, K. M., Dalla Bella, S., Peretz, I., Dunlop, T., Dawe, L. A., Humphrey, G. K., et al. (1999). Prelude or requiem for the Mozart effect? *Nature*, 402, 827.
- Stoep, A. V., Weiss, N. S., Kuo, E. S., Cheney, D., & Cohen, P. (2003). What proportion of failure to complete secondary school in the US population is attributable to adolescent psychiatric disorder? *Journal of Behavioral Health Services and Research*, 30, 119–124.
- Thayer, J. F., & Levenson, R. (1983). Effects of music on psychophysiological responses to a stressful film. *Psychophysiology*, 7, 86–94.
- Thompson, W. F., Schellenberg, E. G., & Husain, G. (2001). Arousal, mood, and the Mozart effect. *Psychological Science*, 12, 248–251.
- Thorndike, R. L., Hagen, E. P., & Sattler, J. M. (1986). *The Stanford-Binet intelligence scale* (4th ed.). Chicago: Riverside Publishing Company.
- Trehub, S. E. (2002). Mothers are musical mentors. *Zero to Three*, 23, 19–22.
- Trevarthen, C. (2001). Infant intersubjectivity: Research, theory and clinical applications. *Annual Research Review, Journal of Child Psychology and Psychiatry*, 42, 3–48.
- Trevarthen, C., & Malloch, S. (2002). Musicality and music before three: Human vitality and invention shared with pride. *Zero to Three*, 23, 10–18.
- Turner, L. A., & Johnson, B. (2003). A model of mastery motivation for at-risk preschoolers. *Journal of Educational Psychology*, 95, 495–505.
- Vaughn, K. (2000). Music and mathematics: Modest support for the oft claimed relationship. *Journal of Aesthetic Education*, 34, 149–166.
- Wechsler, D. (1991). *Wechsler Intelligence Scale for Children* (3rd ed.). San Antonio, TX: Psychological Corporation.
- Werker, J. F., & McLeod, P. J. (1989). Infant preference for both male and female infant-directed talk: A developmental study of attentional and affective responsiveness. *Canadian Journal of Psychology*, 43, 230–246.

- Westerman, R., Spies, K., Stahl, G., & Hesse, F. (1996). Relative effectiveness and validity of mood induction procedures: A meta-analysis. *European Journal of Social Psychology, 26*, 557–580.
- Winner, E., & Cooper, H. (2000). Mute those claims: No evidence (yet) for a causal link between arts study and academic achievement. *Journal of Aesthetic Education, 34*, 11–75.
- Zigler, E., & Styfco, S. J. (1993). Strength in unity: Consolidating federal education programs for young children. In S. J. Styfco (Ed.), *Head Start and beyond: A national plan for extended childhood intervention* (pp. 111–145). New Haven, NJ: Yale University Press.

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