# Music Training and Nonmusical Abilities: Introduction

E. Glenn Schellenberg
*University of Toronto, Mississauga, Ontario, Canada*

Ellen Winner
*Boston College*

**The objective of this special issue of** *Music Perception*, which includes contributions from researchers based in Canada, Germany, New Zealand, and the US, is to present the best new research on associations between music training and nonmusical abilities. Scholarly interest in associations between music training and nonmusical cognitive functioning has sparked much research over the past 15–20 years. The study of how far associations between music training and cognitive abilities extend, and whether such associations are more likely for some domains of cognition than for others, has theoretical relevance for issues of transfer, modularity, and plasticity. Unlike most other areas of scientific inquiry, there is parallel interest on the part of the public, the media, and educators who want to know if nonmusical intellectual and academic benefits are a welcome by-product of sending children to music lessons. Indeed, some educators and arts advocates justify music training in schools precisely because of these presumed and desired nonmusical associations.

The nine articles included in this special issue make it clear that terminology is critical. For example, studying children or adults with varying amounts of formal music training is not the same as comparing professional musicians to nonmusicians. Seven articles focus on music training in childhood, whether the samples comprise children (Corrigall & Trainor; Degé, Kubicek, & Schwarzer; Moreno, Friesen, & Bialystok; Rauscher & Hinton; Tsang & Conrad) or adults (Haimson, Swain, & Winner; Schellenberg). The other two articles focus on differences between adult musicians and nonmusicians (Patston & Tippett; Strait & Kraus). The term "music training" (or "music lessons") is also problematic because training takes many different forms, even beyond distinctions between standard conservatory methods and specialized pedagogies such as Kodály or Suszuki. Ideally, besides specifying the kind of training, the training should be uniform across participants.

Methodology is also crucial. For obvious reasons, very few studies have involved random assignment of children to music lessons. Doing so requires that the researchers have funds to provide music lessons. Moreover, when children are given free lessons weekly, they may practice less than if parents had paid for the lessons (see Schellenberg, 2004, 2011). Consequently, some researchers have opted for random assignment to shorter-term intensive (daily) interventions, in which children are taught in relatively large groups and the lessons focus primarily on music listening instead of performance (Moreno et al., 2009, this issue; Degé & Schwarzer, 2011). It remains unknown whether positive results from these listening-based training programs generalize to typical instrumental or vocal lessons.

Because the majority of the available research in this area is quasi-experimental or correlational, inferences of causation are precluded. Links between music training in childhood and nonmusical abilities are inextricably entangled with self-selection issues and individual differences in socioeconomic status and intelligence (e.g., Schellenberg, 2006, 2011, this issue). This problem can be reduced when professional musicians are compared to other professionals who are not musicians because the two groups are often similar in intelligence (e.g., Helmbold, Rammsayer, & Altenmüller, 2005). Moreover, in some comparisons between musicians and nonmusicians, it is implausible to attribute the observed behavioral and/or neuronal differences to pre-existing individual differences or to a third uncontrolled variable – as, for example, when right-handed string players have enlarged cortical representations for their left-hand fingers, with greater enlargement observed among individuals who started training earlier in life (e.g., Elbert, Pantev, Wienbruch, Rockstroh, & Taub, 1995). Here we can infer a causal link from music training to brain growth with some confidence. Such an effect would stem from intricate and repetitive motor actions, and it is likely that similar brain changes would also be stimulated by nonmusical activities that hone motor skills similarly (e.g., typing).

*Music Perception* volume 29, issue 2, pp. 129–132. issn 0730-7829, electronic issn 1533-8312. DOI: 10.1525/mp.2011.29.2.129

Strait and Kraus (this issue) review a large set of quasi-experiments and conclude that playing music for years on end influences listening abilities at multiple levels (from the brain stem to perception to cognition), which in turn leads to enhanced functioning in related domains where audition is central, such as speech, language, and auditory memory. Although this claim is undoubtedly true, inborn listening abilities (i.e., perceiving and remembering sounds) probably vary across individuals, following a normal distribution like other human characteristics (e.g., height, intelligence). Individuals with poor listening abilities would be unlikely to become professional musicians or to take music lessons for long periods of time, and this "selection" effect could contribute to the positive associations between training and listening documented by Strait and Kraus. More generally, the widely cited claim that musicians represent a model population for the study of plasticity (Münte, Altenmüller, & Jäncke, 2002) assumes that becoming a musician is akin to random assignment, an assumption we reject as implausible. Rather, the association between music training and listening abilities is most likely to be bidirectional, with individuals with naturally good auditory abilities being more likely than other individuals to become musicians, and music training exaggerating their natural advantage. Future research on the association between auditory skills and music training could attempt to disentangle the roles of nature and nurture in the enhanced listening abilities of musicians, using techniques of behavioral genetics in combination with measures of behavior and brain activation.

Four of the nine papers in this issue report associations between music training and language abilities. In one study of children (Corrigall & Trainor), an association between duration of music training and performance on a test of reading comprehension was evident among 6- to 9-year-olds (all with some music lessons), even when full-scale IQ was held constant. In another (Tsang & Conrad), musically trained 5- to 9-year-olds performed better than their untrained counterparts on tests of music aptitude and on a test of phonological awareness (i.e., phoneme deletion). As in the report from Corrigall and Trainor, music training was not associated with word identification. The main finding of Tsang and Conrad, however, was that the pitch component of the aptitude test predicted performance on the test of phonological awareness and on a test of word identification, but only for the musically untrained group. Presumably, enhanced listening abilities meant that performance on the aptitude tests was relatively good among the trained children (i.e., a restricted range of relatively high scores), making it difficult to uncover associations between aptitude and other variables. Nevertheless, this study underscores the importance of considering music training as a moderating variable when examining associations between music aptitude and other auditory skills (Schellenberg & Peretz, 2008).

Moreno et al. (this issue) assigned 4- to 6-year-olds randomly to intensive training (i.e., daily for four weeks) in music listening or visual art. After the training, the music listening group performed better than the visual-art group on a test of symbol-word mapping but not on a test of phonological awareness. The observed effect was weak, however, evident in one analysis (i.e., ANCOVA, with pretest performance held constant) but not in a more standard approach (i.e., mixed-design ANOVA) that tested whether improvements from pre to posttest differed between groups. Regardless, results from these three studies of music training in childhood converge: each found an association between music training and an ability relevant to reading. Rauscher and Hinton (this issue) described a case of similar enhancement in phonological awareness among 5-year-olds taking violin lessons. The findings diverge, however, because an association between phonological awareness and music training was evident in quasi-experiments with traditional music training (Rauscher & Hinton, Tsang & Conrad), but not in an experiment with listening-based training (Moreno et al., this issue). Similarly, whereas two papers (Corrigall & Trainor; Tsang & Conrad) reported no association between simple word reading and training in correlational and quasi-experimental studies, respectively, Moreno et al. found an association on a related task that required children to learn arbitrary symbol-word correspondences. The fact that all of the discrepancies are with the findings of Moreno et al. suggests that intensive listening-based music training is qualitatively different from performance-based music training, at least in terms of its associations with linguistic abilities. Differences in age, the specific task, or the design of the study may also have played a role.

Patston and Tippett (this issue) examined the influence of background music on two tests (grammaticality judgments and visual search), asking whether interference effects might differ for adult musicians compared to nonmusicians. Background music disrupted performance on the grammaticality test only for musicians. In line with the studies of reading in childhood, this finding is consistent with the possibility of an association between music training and linguistic abilities, though again, it is possible that those who become musicians show this music-language link prior to any training. On the one hand, because the musician group also performed better in general across the two tasks, a more

general link between music training and cognitive functioning was implicated. On the other hand, the two groups did not differ on a test that required them to pronounce irregularly spelled words or on a test of fluid intelligence, although the musicians performed better in absolute terms in both cases.

In another study of adults with and without music training, Schellenberg (this issue) measured IQ and emotional intelligence. The music group had higher IQs but the groups did not differ in emotional intelligence. These findings point again to a link between music training and cognitive functioning that is general (i.e., evident on a test of IQ) but strictly cognitive (i.e., not evident on a test of emotional intelligence; see also Schellenberg, 2004, 2006). One would thus predict positive associations in performance across cognitive tests, which proved to be inconsistent in the study by Patson and Tippett (this issue). This discrepancy could be due to differences in tests or sample sizes (Schellenberg's was almost 50% larger), or because Patston and Tippett compared musicians to nonmusicians whereas Schellenberg compared undergraduates with or without music training.

Converging evidence of general associations between cognitive abilities and music training comes from the contribution of Degé et al. (this issue), who studied 9- to 12-year-olds with varying amounts of music training. The results revealed positive associations between duration of music training and IQ, as well as with five different measures of executive function. Because the association between duration of training and IQ disappeared when the measures of executive function were held constant, executive functions appear to act as mediators between training and IQ. These results are important because they reveal mechanisms that have been hypothesized to explain the association between music lessons and IQ (Hannon & Trainor, 2007; Schelenberg & Peretz, 2008). Nevertheless, they stand in direct conflict with those of Schellenberg (2011), who asked the same research question with children the same age. In his study, musically trained children had substantially higher IQs than their untrained counterparts (2/3 of a *SD*), but the two groups did not differ on four of five measures of executive function and there was no evidence that the association between music lessons and IQ was mediated by executive functions. The discrepancy between studies could stem from different designs (correlational vs. quasi-experimental), different training, different tests used to measure IQ and/or executive functions, or cultural differences (Germany vs Canada).

In a novel approach, Haimson et al. (this issue) treated musical expertise (or musicality) as the criterion variable rather than the predictor. They used the internet to recruit a large sample of mathematicians and language scholars, all of whom had doctoral degrees. Their aim was to test the widely held view of a special link between music and mathematics (e.g., Rothstein, 2006). Each participant completed a survey that included multiple questions about their musical abilities. Because no differences between groups were evident, there was no evidence that the mathematicians were particularly musical. Although a null finding cannot be interpreted definitively and the web-based approach lacked the control of laboratory studies, the findings suggest that if there is an association between music and mathematical ability, it is likely to be small and without practical significance.

The association between mathematics and music was also examined in the contribution from Rauscher and Hinton (this issue). In general, at-risk (Head Start) as well as middle-class children assigned to music lessons performed better on tests of mathematical and visuospatial abilities after training compared to children who were assigned to control groups (computer lessons or no lessons), provided the music training began before the age of 7. Thus, even though natural musical and mathematical abilities may be independent (Haimson et al., this issue), music training may improve mathematical ability. Raucher and Hinton's review also shows us that the quality of training might be an important mediator of associations between music lessons and cognitive ability, as might the teacher's gender.

The contributions to this special issue provide evidence of associations between music training and listening abilities, language abilities, mathematical abilities, visuospatial abilities, and general cognitive functioning. They also raise many additional questions that can be answered only by future research. Some of these questions concern the extent of the associations, their specificity, and the direction of causation. Others include the possibility of differential effects for different types of music training, and for those who take music lessons in childhood compared to those who devote their life to making music.

## Author Note

We thank the authors who contributed to this special issue, the reviewers for their time and effort, and Lola Cuddy for her encouragement and helpful comments.

*Correspondence concerning this article should be addressed to* Glenn Schellenberg, Department of Psychology, University of Toronto Mississauga, Mississauga, ON, Canada L5L 1C6. E-mail: g.schellenberg@utoronto.ca

## References


Corrigall, K. A., & Trainor, L. J. (2011). Associations between length of music training and reading skills in children. *Music Perception, 29,* 149–157.

Degé, F., Kubicek, C., & Schwarzer, G. (2011). Music lessons and intelligence: A relation mediated by executive functions. *Music Perception, 29,* 197–203.

Degé, F., & Schwarzer, G. (2011). The effect of a music program on phonological awareness in preschoolers. *Frontiers in Psychology, 2*, Article 24. doi: 10.3389/fpsyg.2011.00124

Elbert, T., Pantev, C., Wienbrich, C., Rockstroh, B., & Taub, E. (1995). Increased cortical representation of the left hand in string players. *Science, 270*, 305–307.

Haimson, J., Swain, D., & Winner, E. (2011). Do mathematicians have above average musical skill? *Music Perception, 29,* 205–215.

Hannon, E. E., & Trainor, L. J. (2007). Music acquisition: Effects of enculturation and formal training on development. *Trends in Cognitive Sciences, 11,* 466–472.

Helmbold, N., Rammsayer, T., & Altenmüller, E. (2005). Differences in primary mental abilities between musicians and nonmusicians. *Journal of Individual Differences, 26,* 74–85.

Moreno, S., Friesen, D., & Bialystok, E. (2011). Effect of music training on promoting preliteracy skills: Preliminary causal evidence. *Music Perception, 29,* 167–174.

Moreno, S., Marques, C., Santos, A., Santos, M., Castro, S. L., & Besson, M. (2009). Musical training influence linguistic abilities in 8-year-old children: More evidence for brain plasiticity. *Cerebral Cortex, 19*, 712–723.

Münte, T. F., Altenmüller, E., & Jäncke, L. (2002). The musician's brain as a model of neuroplasticity. *Nature Reviews Neuroscience, 3*, 473–478.

Patston, L. L. M., & Tippett, L, J, (2011). The effect of background music on cognitive performance in musicians and nonmusicians. *Music Perception, 29,* 175–185.

Rauscher, F. H., & Hinton, S. C. (2011). Music instruction and its diverse extra-musical benefits. *Music Perception, 29,* 217–228.

Rothstein, E. (2006). *Emblems of the mind: The inner life of music and mathematics.* Chicago, IL: University of Chicago Press.

Schellenberg, E. G. (2004). Music lessons enhance IQ. *Psychological Science, 15*, 511–514.

Schellenberg, E. G. (2006). Long-term positive associations between music lessons and IQ. *Journal of Educational Psychology, 98*, 457–468.

Schellenberg, E. G. (2011). Examining the association between music lessons and intelligence. *British Journal of Psychology, 102*, 283–302.

Schellenberg, E. G. (2011). Music lessons, emotional intelligence, and IQ. *Music Perception, 29,* 187–196.

Schellenberg, E. G., & Peretz, I. (2008). Music, language, and cognition: Unresolved issues. *Trends in Cognitive Sciences, 12*, 45–46.

Strait, D., & Kraus, N. (2011). Playing music for a smarter ear: Cognitive, perceptual and neurobiological evidence. *Music Perception, 29,* 133–147.

Tsang, C. D., & Conrad, N. J. (2011). Music training and reading readiness. *Music Perception, 29.*