Music lessons and nonmusical abilities: Conclusions and controversies

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One Firm Conclusion

• Taking music lessons is associated positively with cognitive functioning.
Outstanding Questions

• Are the associations between music lessons and cognition general or specific?

• Do music lessons cause improvements in cognitive ability, or are high-functioning children more likely to take music lessons?

• Is the association between music lessons and cognitive abilities direct, or mediated by some other variable(s)?
Outstanding Questions

• Are nonmusical associations with music training strictly intellectual?
Music Lessons & Listening

- Taking music lessons is associated positively with listening skills

- Music tasks: e.g., knowing whether a chord sequence ends well (i.e., on the tonic), identifying tunes played unusually slow or fast, identifying a mistuned note in a familiar melody

(Corrigall & Trainor, 2006; Andrews, Dowling, Bartlett, & Halpern, 1998; Schellenberg & Moreno, 2010)
Taking music lessons is associated positively with listening skills.

Other listening tasks: e.g., (1) frequency discrimination, (2) auditory processing speed, (3) low levels of informational masking in auditory psychophysical tasks.

In short, musically trained people are good listeners.
• **Taking music lessons is associated positively with language abilities**

• e.g., remembering prose or lists of words, reading ability, vocabulary, sequencing verbal information, detecting pitch violations in speech, decoding emotions conveyed by prosody in speech

(Brandler & Rammsayer, 2003; Chan et al., 1998; Douglas & Willatts, 1994; Forgeard et al., 2008; Franklin et al., 2008; Gardiner et al., 1996; Ho et al., 2003; Jakobson et al., 2003, 2008; Kilgour et al., 2000; Magne et al., 2006; Marques et al., 2007; Moreno et al., 2009; Piro & Ortiz, 2009; Schön et al., 2004; Thompson et al, 2004)
• Taking music lessons is associated positively with non-linguistic cognitive abilities

• e.g., spatial abilities, mathematical, and nonverbal abilities; short-term, working, and visual memory; reaction times; and visual-motor integration

(Bahr & Christensen, 2000; Bilhartz et al., 2000; Brouchard et al., 2004; Bugos et al., 2007; Cheek & Smith, 1999; Costa-Giomi, 2005; Forgeard et al., 2008; Franklin et al., 2008; Gardiner et al., 1996; Graziano et al., 1999; Gromko & Poorman, 1998; Hetland, 2000; Hughes & Franz, 2007; Huntsinger & Jose, 1991; Jakobson et al., 2008; Lee et al., 2007; Neufeld, 1986; Orsmond & Miller, 1999; Patston et al., 2006, 2007; Rauscher, 2002; Rauscher et al., 1997; Sluming et al., 2007; Stoesz et al., 2007; Thompson et al., 2004; Tierney et al., 2008; Trimmer & Cuddy, 2008; Vaughn, 2000; Zafranas, 2004)
When the available literature is considered as a whole, associations between music lessons and cognitive abilities are extremely general (i.e., not limited to language, mathematical, or spatial abilities).
Specific vs General?

- Evidence for a specific association requires that it remains significant when a reliable and valid measure of general intelligence (e.g., Full-Scale IQ; FSIQ) is held constant.
Correlational Study 1

(Schellenberg, 2006)

- 147 6- to 12-year-olds
- Measured IQ (WISC-III), school performance, and social skills.
- Parents provided information about child’s history of music lessons, family income, parents’ highest level of education, child’s involvement in organized out-of-school activities, and child’s school performance.
Correlational Study 1
(Schellenberg, 2006)

- Involvement in non-musical out-of-school activities was *not* associated with IQ.

- In general, the longer the duration of music lessons, the higher the IQ, the better the performance in school, & the higher the score on a test of educational achievement (a dose-response association)

  \[ r \approx .35, \ p < .0001; \ pr \approx .25, \ p < .005 \]
Correlational Study 1

(Schellenberg, 2006)

- In each case, the association was strongest for the aggregate measure.
- No associations with specific subtests or indexes were evident when general intelligence was held constant.
- The link between music lessons and academic average was evident even when general intelligence was held constant. *
• Music training was not associated with social skills.
Correlational Study 2

(Wetter, Koerner, & Schwaninger, 2009)

- 120 Swiss 9- to 12-year-olds, private music lessons or no lessons.
- Music group had higher grades in all school subjects except for sports; effect was stronger for older students with more lessons.
- Advantage for music group was evident when family income and child’s grade level were held constant.
Are musicians geniuses?

- Obviously not.
- Association breaks down when university students (in music vs other disciplines) are tested, or when students with 10+ years of lessons are compared to other students.

(Bialystok & DePape, 2009; Brandler & Rammsayer, 2003; Helmbold et al., 2005; Schellenberg & Moreno, 2010)
Most of the available findings are inconclusive. Why?

(1) Small samples of children were trained in ways that differ from typical music lessons.
(Douglas & Willats, 1994; Gardiner et al., 1996; Graziano et al., 1999; Gromko & Poorman, 1998; Moreno et al., 2009)

(2) Assignment to intervention and control conditions was not random.
(Bilhartz et al., 2000; Gardiner et al., 1996; Graziano et al., 1999; Rauscher et al., 1997)
• Most of the available findings are inconclusive. Why?

• (3) The sample suffered from high attrition.
  (Rauscher et al., 1997; Thompson et al., 2004)

• (4) Control conditions involved no lessons of any kind or activities that were not comparable to music lessons.
  (Bilhartz et al., 2000; Douglas & Willats, 1994; Gardiner et al., 1996; Gromko & Poorman, 1998; Douglas & Willats, 1994; Gardiner et al., 1996; Graziano et al., 1999; Gromko & Poorman, 1998; Rauscher et al. 1997)
• Families recruited for free arts lessons.

• 144 6-year-olds assigned randomly to weekly lessons for a year.

• 2 music groups (keyboard or voice lessons)

• 2 control groups (drama or no lessons)
An Exception
(Schellenberg, 2004)

• All children tested before and after the lessons

• WISC-III, educational achievement, social skills
An Exception
(Schellenberg, 2004)

Mean Increase in Full-Scale IQ

- Keyboard
- Voice
- Drama
- No Lessons

Music
Control
An Exception
(Schellenberg, 2004)
• Effects were evident across the various subtests and indexes of the WISC, across different school subjects, and strongest for the most general measures.

• Only the drama group showed significant improvement in social skills.
BUT...

Providing lessons for free meant that participating families differed from those who pay for lessons.

Practice between lessons was minimal.

Differential attrition across conditions \((p = .06)\), but those who stayed or dropped out did not differ in FSIQ at Time 1.
Causation?

• One well-designed but artificial experiment provides evidence that music lessons enhance IQ slightly.

• A mountain of other evidence indicates that high-functioning children are more likely than other children to take music lessons, and to do well on any test they take.
Causation?

• Random assignment vs. parsimony, must we choose?

• No. High-functioning children could be more likely than other children to take music lessons, which, in turn, exaggerate individual differences in cognitive ability.

• The effect is circular (or bi-directional).
Causation?

Music Lessons

Cognition
Mediation

• IQ is stable across the lifespan. If music lessons cause small increases in IQ, the association may be mediated by executive function (EF). (Hannon & Trainor, 2008; Schellenberg & Peretz, 2009)

• EF involves conscious goal-directed problem solving, cognitive flexibility, working memory, ignoring irrelevant information (selective attention), and inhibiting inappropriate responses.
Mediation

- The hypothesis

Diagram:
- Music Lessons
- EF
- IQ
Mediation

• Previous evidence of a link between music training and EF is weak.
  (Bialystok & DePape, 2009; Bugos et al., 2007)
• 106 9- to 12-year-olds; half musically trained, half untrained.

• Each child tested individually on a brief measure of IQ (WASI--Wechsler Abbreviated Scale of Intelligence) and 5 EF tasks

• WASI has 4 subtests that yield FSIQ, Verbal IQ, and Performance IQ scores
• Executive function tests:
  • Wisconsin Card Sort
  • Tower of Hanoi
  • Sun-Moon Stroop
  • Phonological Fluency
  • Digit Span
• Wisconsin Card Sort
Music lessons, EF, & IQ

(Schellenberg, 2011)

- Tower of Hanoi
Music lessons, EF, & IQ

(Schellenberg, 2011)

- Sun-Moon Stroop
Music lessons, EF, & IQ

(Schellenberg, 2011)

- Phonological Fluency
- Digit Span
Music lessons, EF, & IQ
(Schellenberg, 2011)

- Demographic variables:
  - Family income
  - Parents’ education
  - Parents’ first language
  - Involvement in nonmusical activities
• Results--Music lessons and IQ:
Results--Music lessons and IQ:

[Bar chart showing mean T score for Vocab, BD, Sim, and MR (Trained vs. Untrained)]
Results--EF and IQ:

<table>
<thead>
<tr>
<th>Task</th>
<th>FSIQ</th>
<th>PIQ</th>
<th>VIQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digit Span</td>
<td>.37*</td>
<td>.42*</td>
<td>.24*</td>
</tr>
<tr>
<td>Phonological fluency</td>
<td>.27*</td>
<td>.25*</td>
<td>.20*</td>
</tr>
<tr>
<td>Sun-Moon Stroop</td>
<td>.24*</td>
<td>.26*</td>
<td>.15</td>
</tr>
<tr>
<td>Tower of Hanoi</td>
<td>-.38*</td>
<td>-.32*</td>
<td>-.35*</td>
</tr>
<tr>
<td>Wisconsin Card Sorting Test</td>
<td>.33*</td>
<td>.32*</td>
<td>.26*</td>
</tr>
</tbody>
</table>

*p < .05
Results--Music lessons and EF:

- No differences between groups across the 5 EF tests (MANOVA).
- Separate analyses for each test: Trained children better only on Digit Span.
- Digit Span is also a subtest of more comprehensive measures of IQ.
Music lessons, EF, & IQ
(Schellenberg, 2011)

- Results--Music lessons and EF:
Results--Hierarchical Multiple Regression

- Dependent variable: FSIQ
- Step 1: Demographic variables (11.7%)
- Step 2: + EF variables (+23.8%)
- Step 3: + Music lessons (+ 11.2%)
Music lessons, EF, & IQ

(Schellenberg, 2011)
Music lessons, EF, & IQ

(Schellenberg, 2011)
Music lessons, EF, & IQ

(Schellenberg, 2011)
Conclusions

- The associations between music lessons and cognition are *general* (except they don’t extend to EF).
- High-functioning children are more likely than other children to take music lessons, which may exaggerate pre-existing individual differences in cognitive ability.
Conclusions

• The association between music lessons and cognitive abilities is not mediated by EF, but it could be mediated by other, unidentified variable(s).
Social/Emotional Abilities

- No association between music lessons and social skills (parent reports) \cite{Schellenberg2004, Schellenberg2006}

- What about emotional intelligence (EI/EQ)?
EI: Adults

(Schellenberg, in press)

- Musically trained (≥ 8 years) and untrained adults
- Mayer-Salovey-Caruso Test of Emotional Intelligence (MSCEIT)
- Kaufman Brief Intelligence Test (K-BIT)
• **Usual difference in IQ**
EI: Adults

(Schellenberg, in press)

- No difference in EI
EI: Children
(Schellenberg & Mankarious, in preparation)

• Musically trained (≥ 1 year) and untrained 7- and 8-year-olds
• Test of Emotional Comprehension (TEC)
• Wechsler Abbreviated Scale of Intelligence (WASI)
EI: Children
(Schellenberg & Mankarious, in preparation)

• Usual difference in IQ
EI: Children
(Schellenberg & Mankarious, in preparation)

- Trained children: Higher EI
EI: Children
(Schellenberg & Mankarious, in preparation)

- But IQ was correlated with EI ($r \approx .5$)
- Association between training and EI disappeared when IQ was held constant
EI: Children

(Schellenberg & Mankarious, in preparation)
Causation & Neuroscience

- “The musician’s brain as a model of neuroplasticity” (Münte et al., 2002)
- “a good model to study brain plasticity and the effects of specific experience” (Trainor et al., 2009)
- “The musician's brain has come to serve as a model system for the study of expertise-related changes in the brain” (Berkowitz & Ansari, 2010)
“musical training provides a good and adequate neuroscientific model to study multimodal brain plasticity effects in humans” (Lappe et al., 2008)

Problem 1: Virtually all of these neuroscience studies are quasi-experiments, yet they (almost) always infer causation.
Problem 2: Although it’s clear that our experiences change our behaviour (and our brains), it’s also clear that there is a genetic component to virtually all behaviours.

Music training is associated with FSIQ. Genetics explains 50-75% of the variance in FSIQ, and FSIQ has to be instantiated in brain structure and function.
Conclusion: Music training is better characterized as a model for studying preexisting differences on brain and cognitive development rather than plasticity.
School Performance

- Music training predicts school performance even when FSIQ is held constant. In other words, children who take music lessons perform better in school than you would predict based on their intelligence. (Schellenberg, 2006)

- Other individual differences that distinguish children who take music lessons from other children are likely to include personality variables.
School Performance

- One likely candidate is conscientiousness, the dimension of personality linked most closely with academic achievement. (Bratko et al., 2006; De Fruyt et al., 2008; Dollinger & Orf, 1991; Furnham et al., 2003; Lounsbury et al., 2003; Paunonen & Ashton, 2001)

- Consideration of personality variables in combination with cognitive variables could improve our understanding of why musically trained children do well in school.
Questions?