

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

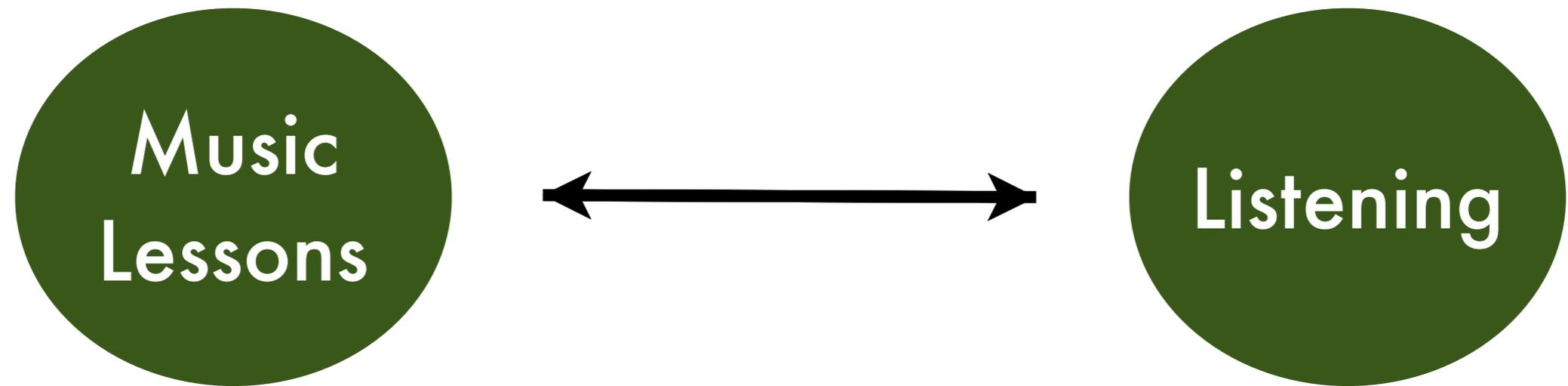
- *Taking music lessons is associated positively with listening skills*
- Music tasks: e.g., knowing whether a chord sequence ends well (i.e., on the tonic), identifying tunes played unusually slow or fast, identifying a mistuned note in a familiar melody

(Corrigall & Trainor, 2006; Andrews, Dowling, Bartlett, & Halpern, 1998; Schellenberg & Moreno, 2010)

Music Lessons & Listening

- *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
(Oxenham, Fligor, Mason, & Kidd, 2003; Schellenberg & Moreno, 2010)
- In short, musically trained people are good listeners

Music Lessons & Listening



Music Lessons & Language

- *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)

Music Lessons & Cognition

- *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; Zafranias, 2004)

Specific vs General?

- When the available literature is considered as a whole, associations between music lessons 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. *

Correlational Study 1

(Schellenberg, 2006)

- 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)

Experiments & Causation

- 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)

Experiments & Causation

- 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)

An Exception

(Schellenberg, 2004)

- 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)

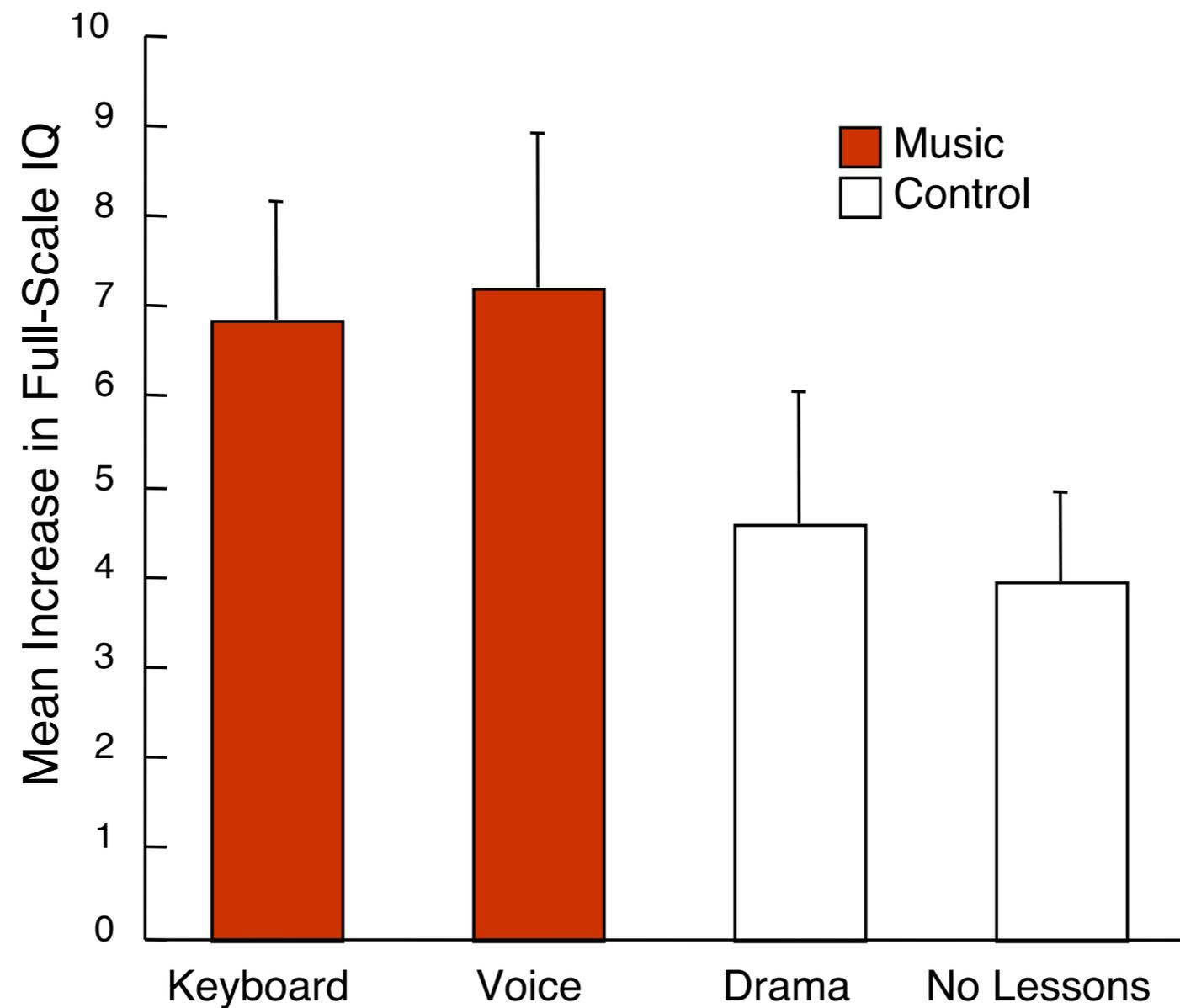
An Exception

(Schellenberg, 2004)

- All children tested before and after the lessons
- WISC-III, educational achievement, social skills

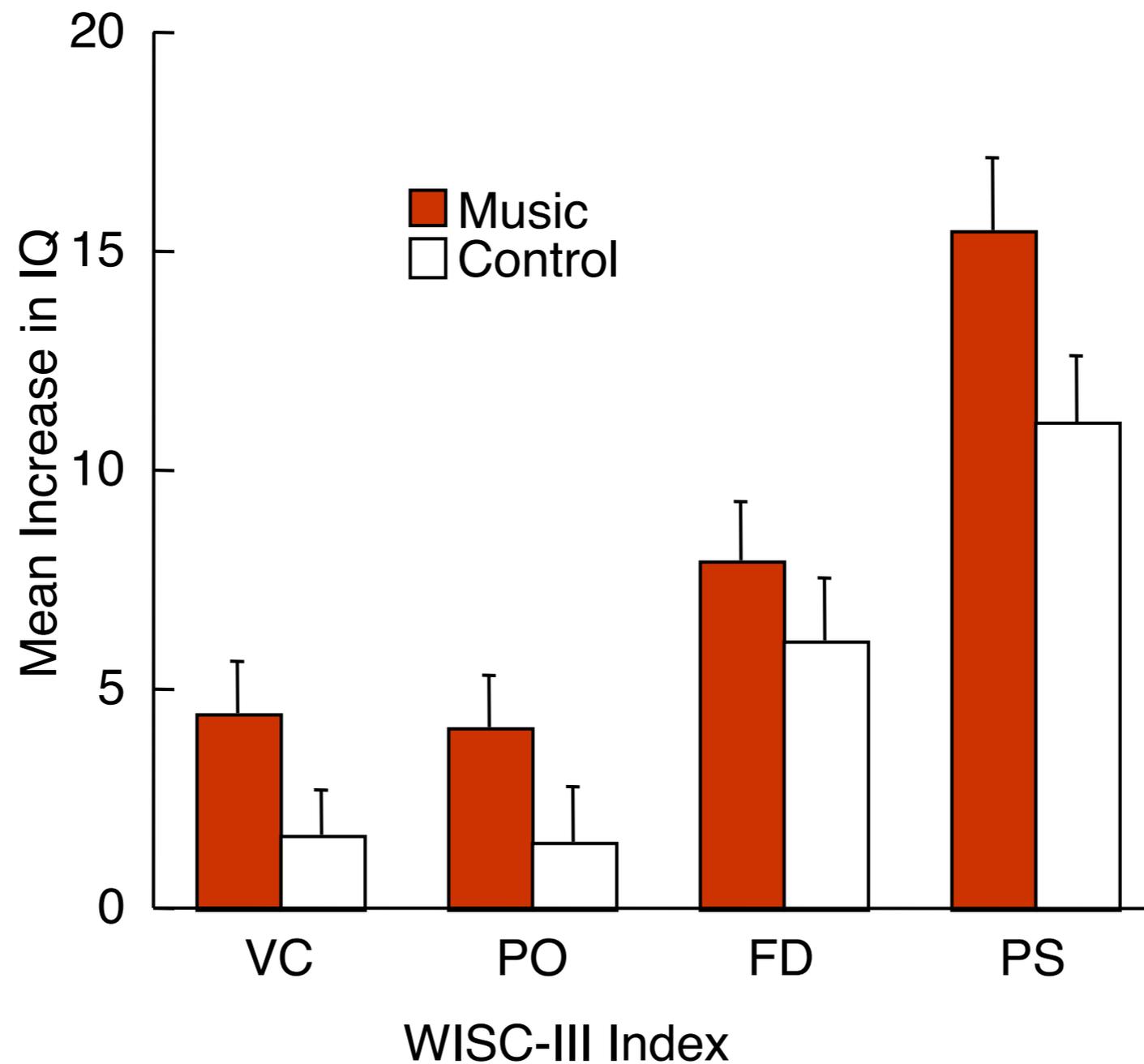
An Exception

(Schellenberg, 2004)



An Exception

(Schellenberg, 2004)



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.

An Exception

(Schellenberg, 2004)

- 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.

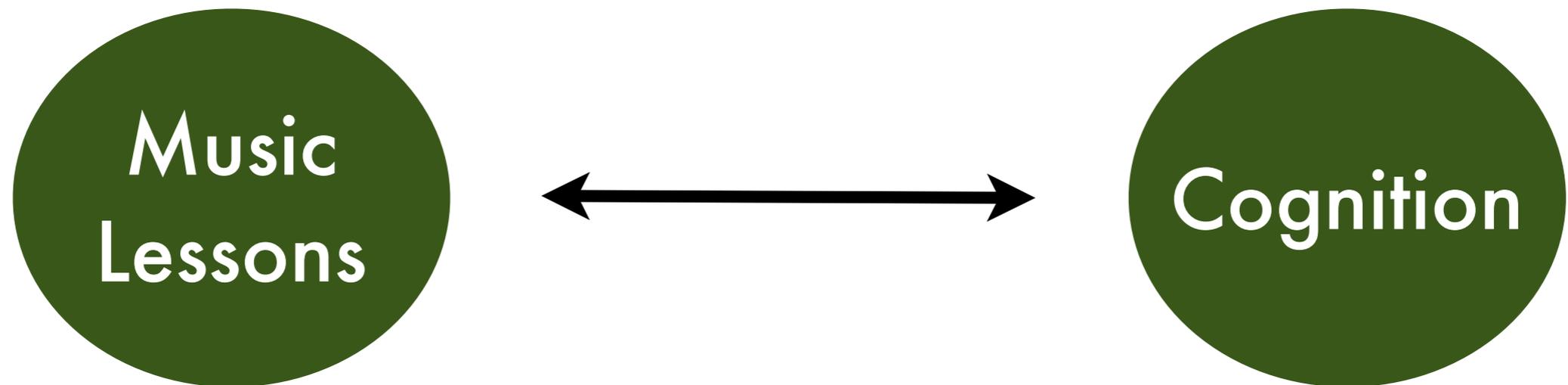
Causation?

- 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?

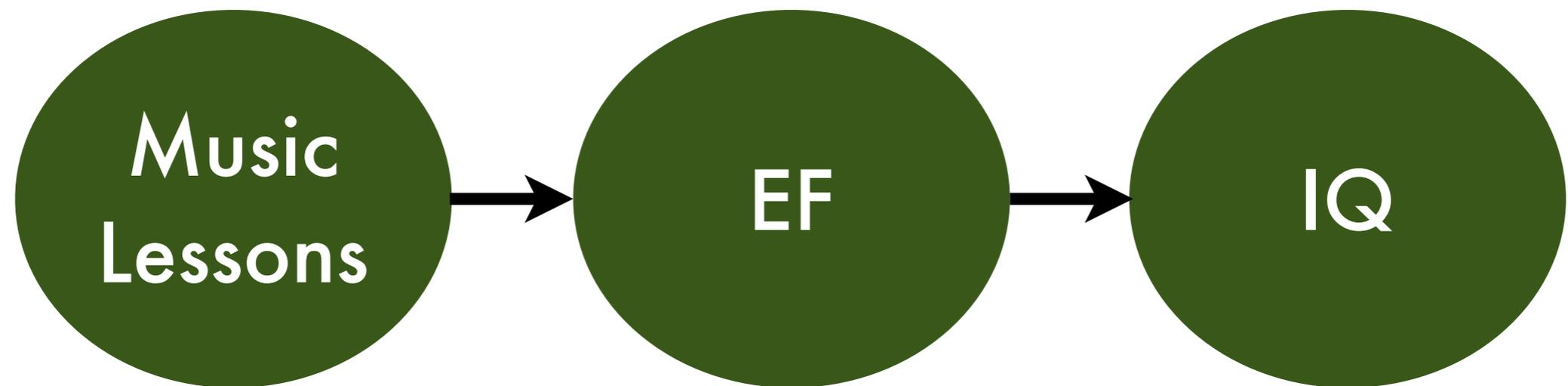


Mediation

- 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



Mediation

- Previous evidence of a link between music training and EF is weak.

(Bialystok & DePape, 2009; Bugos et al., 2007)

Music lessons, EF, & IQ

(Schellenberg, 2011)

- 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

Music lessons, EF, & IQ

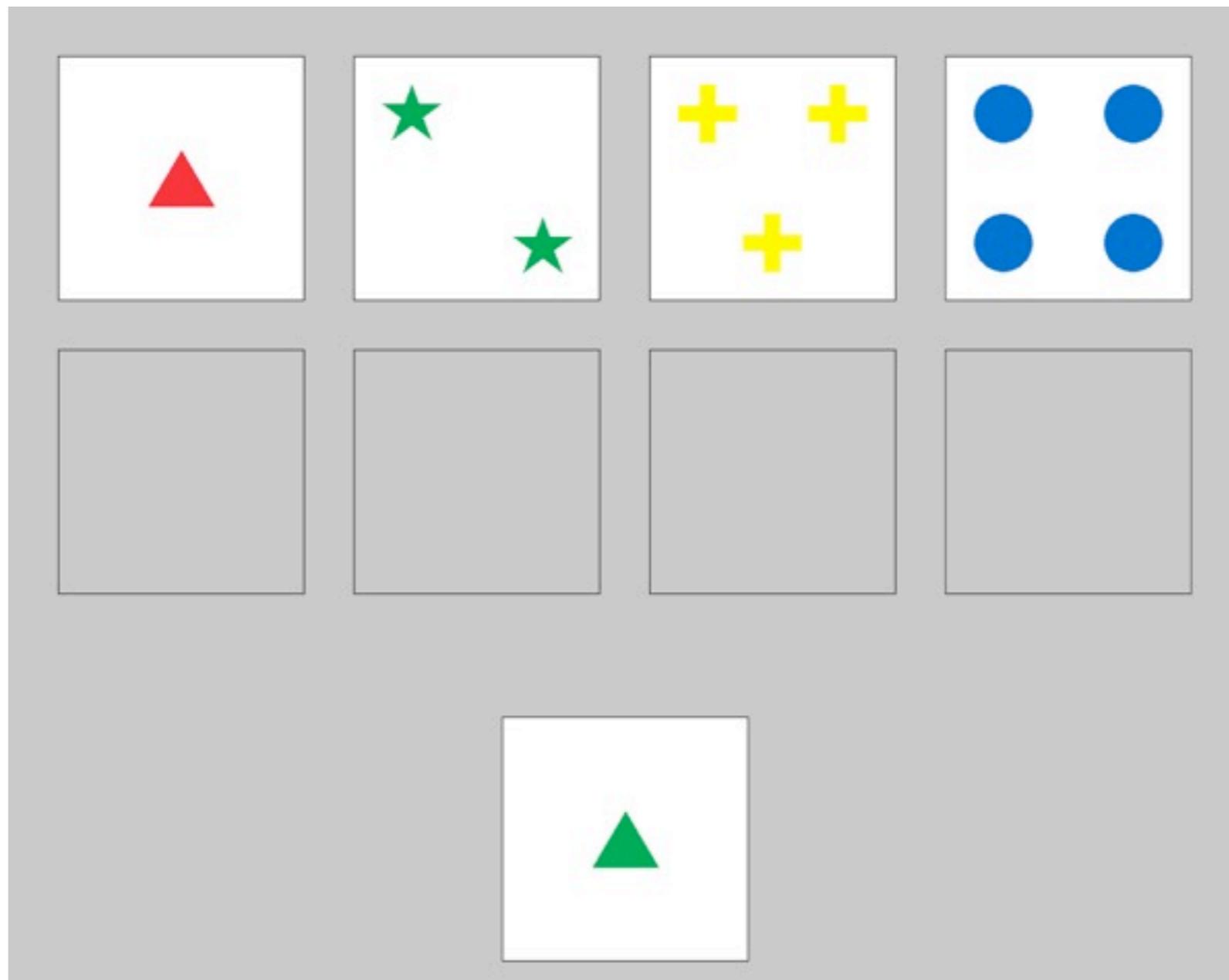
(Schellenberg, 2011)

- Executive function tests:
 - Wisconsin Card Sort
 - Tower of Hanoi
 - Sun-Moon Stroop
 - Phonological Fluency
 - Digit Span

Music lessons, EF, & IQ

(Schellenberg, 2011)

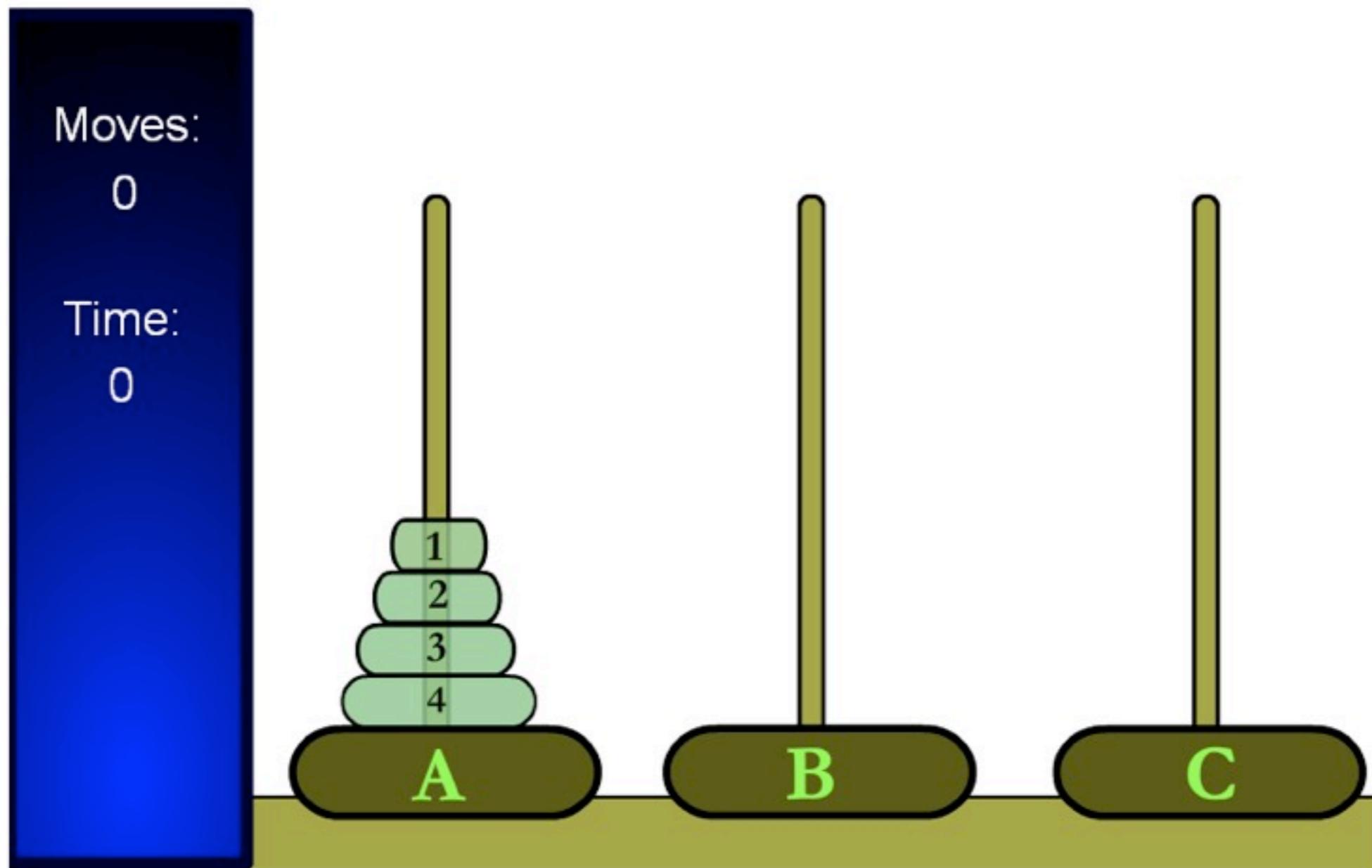
- Wisconsin Card Sort



Music lessons, EF, & IQ

(Schellenberg, 2011)

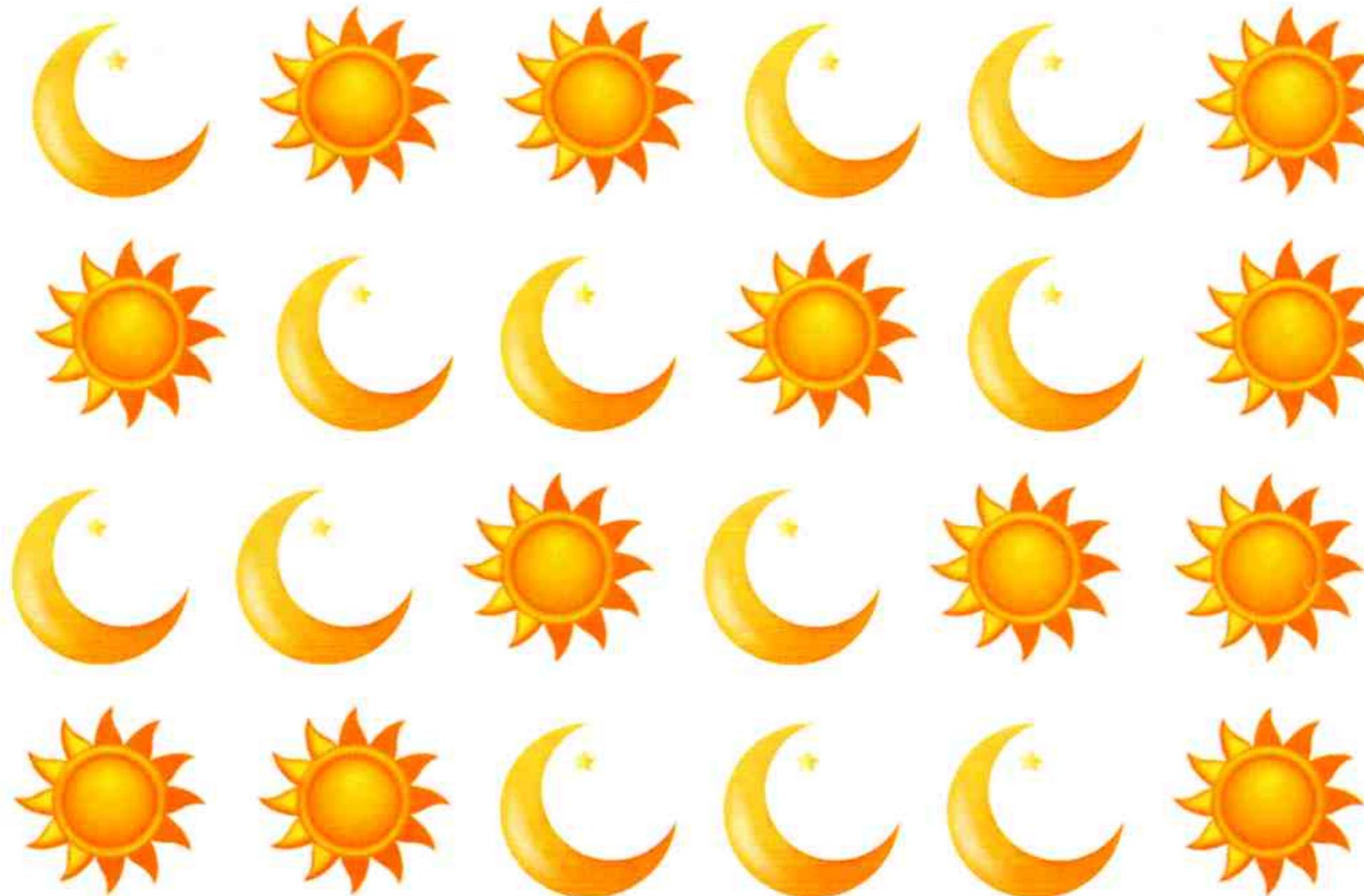
- Tower of Hanoi



Music lessons, EF, & IQ

(Schellenberg, 2011)

- Sun-Moon Stroop



Music lessons, EF, & IQ

(Schellenberg, 2011)

- Phonological Fluency
- Digit Span

Music lessons, EF, & IQ

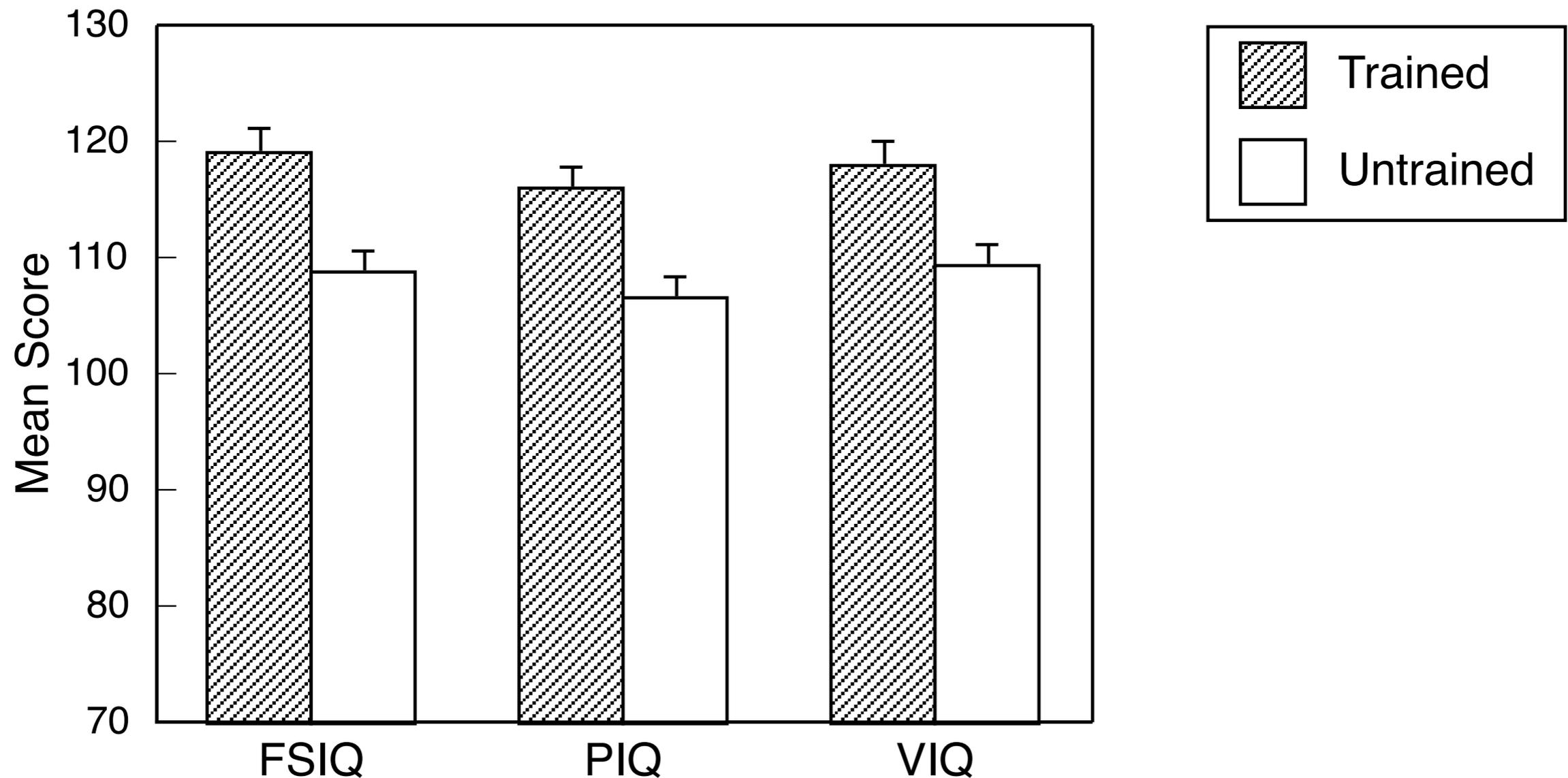
(Schellenberg, 2011)

- Demographic variables:
 - Family income
 - Parents' education
 - Parents' first language
 - Involvement in nonmusical activities

Music lessons, EF, & IQ

(Schellenberg, 2011)

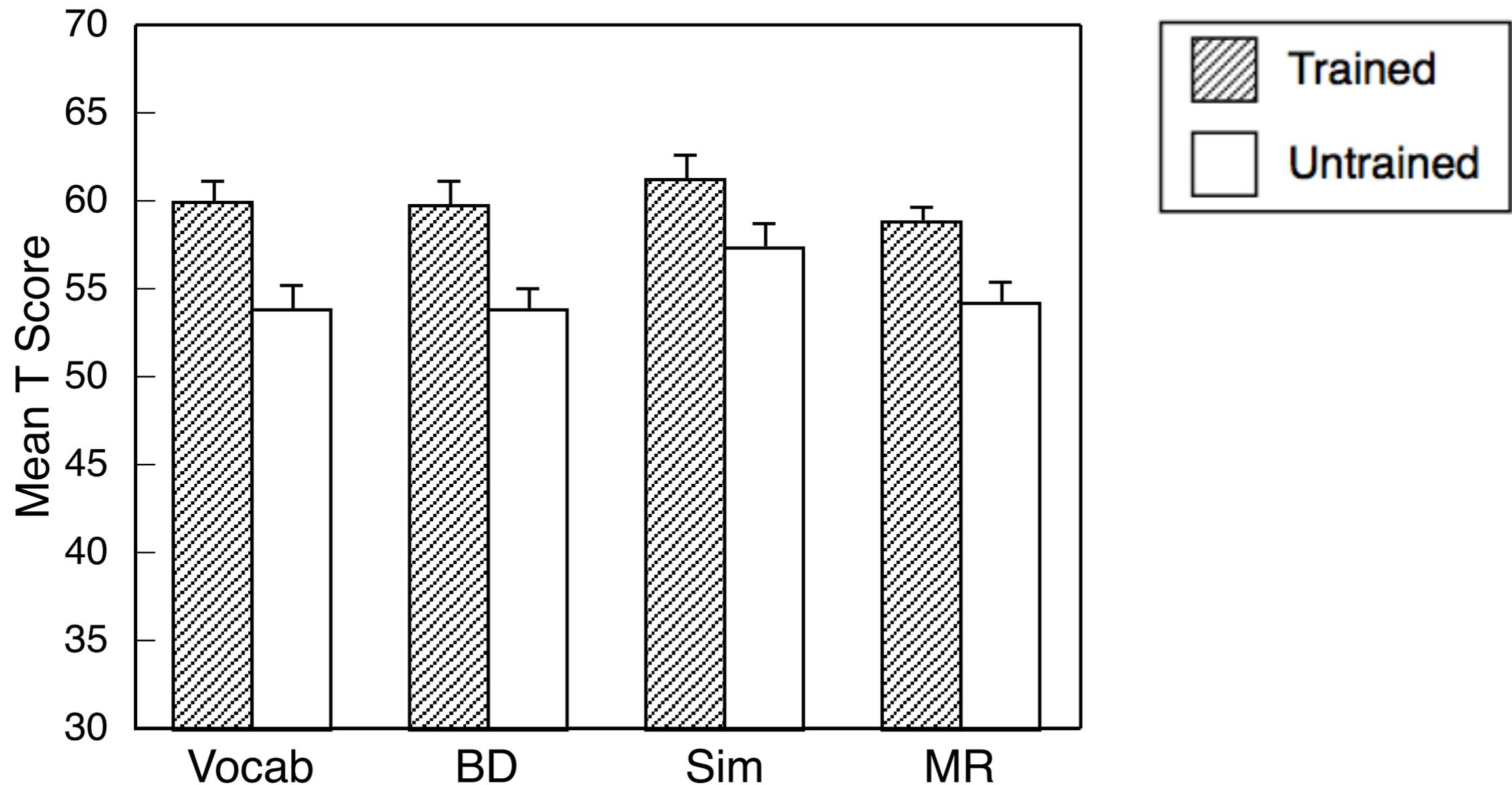
- Results--Music lessons and IQ:



Music lessons, EF, & IQ

(Schellenberg, 2011)

- Results--Music lessons and IQ:



Music lessons, EF, & IQ

(Schellenberg, 2011)

- Results--EF and IQ:

	FSIQ	PIQ	VIQ
Digit Span	.37*	.42*	.24*
Phonological fluency	.27*	.25*	.20*
Sun-Moon Stroop	.24*	.26*	.15
Tower of Hanoi	-.38*	-.32*	-.35*
Wisconsin Card Sorting Test	.33*	.32*	.26*

* $p < .05$

Music lessons, EF, & IQ

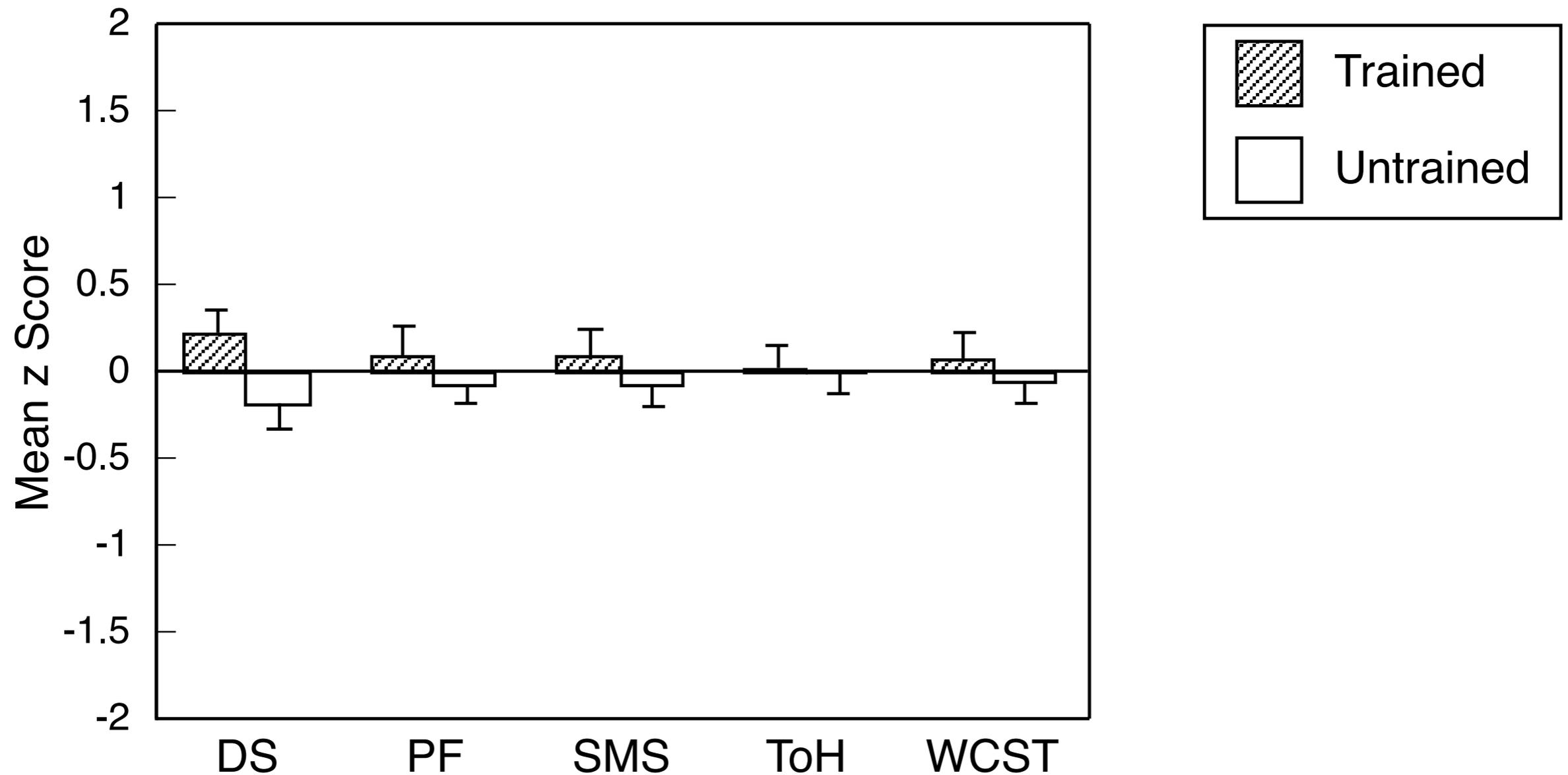
(Schellenberg, 2011)

- 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:



Music lessons, EF, & IQ

(Schellenberg, 2011)

- 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%)

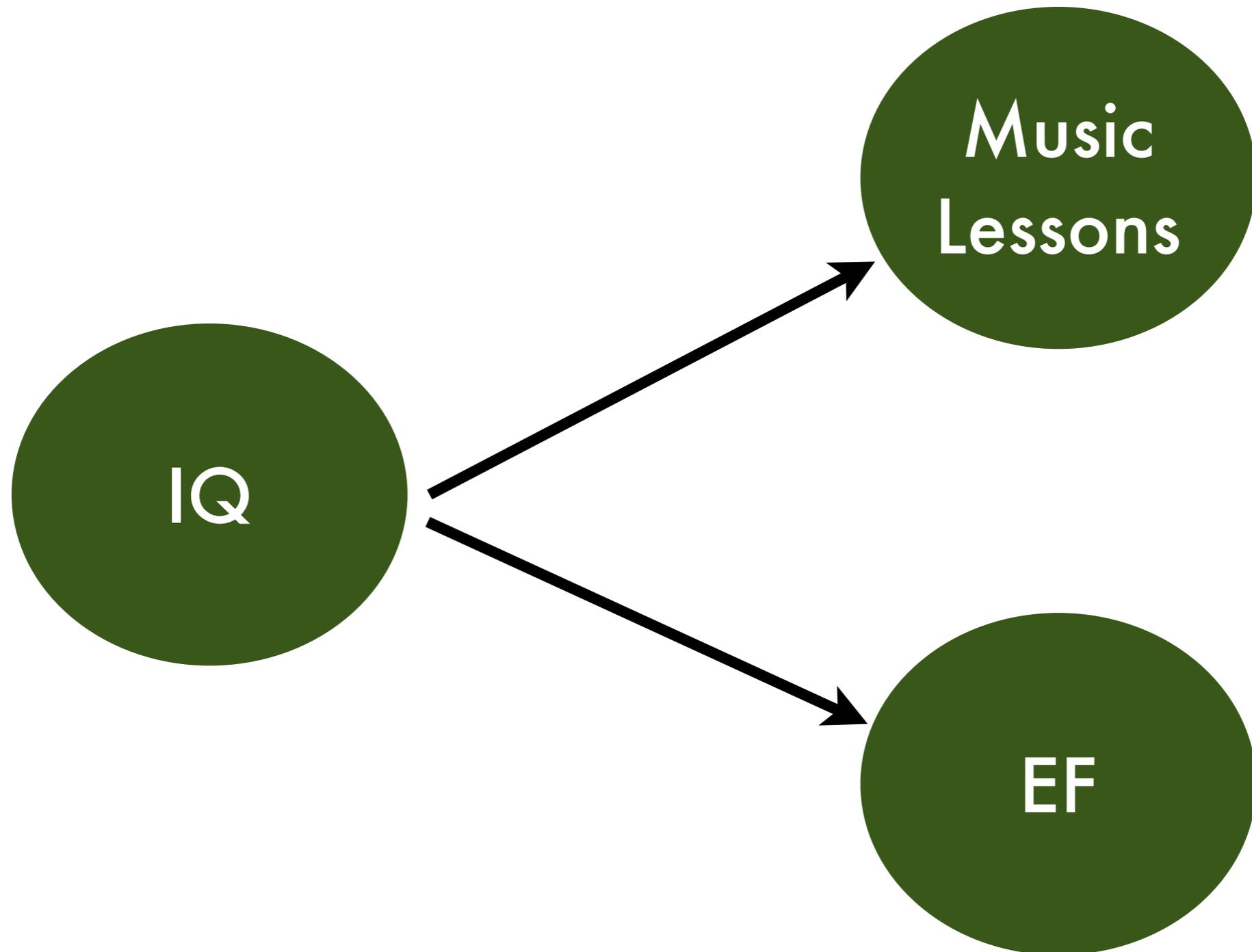
Music lessons, EF, & IQ

(Schellenberg, 2011)



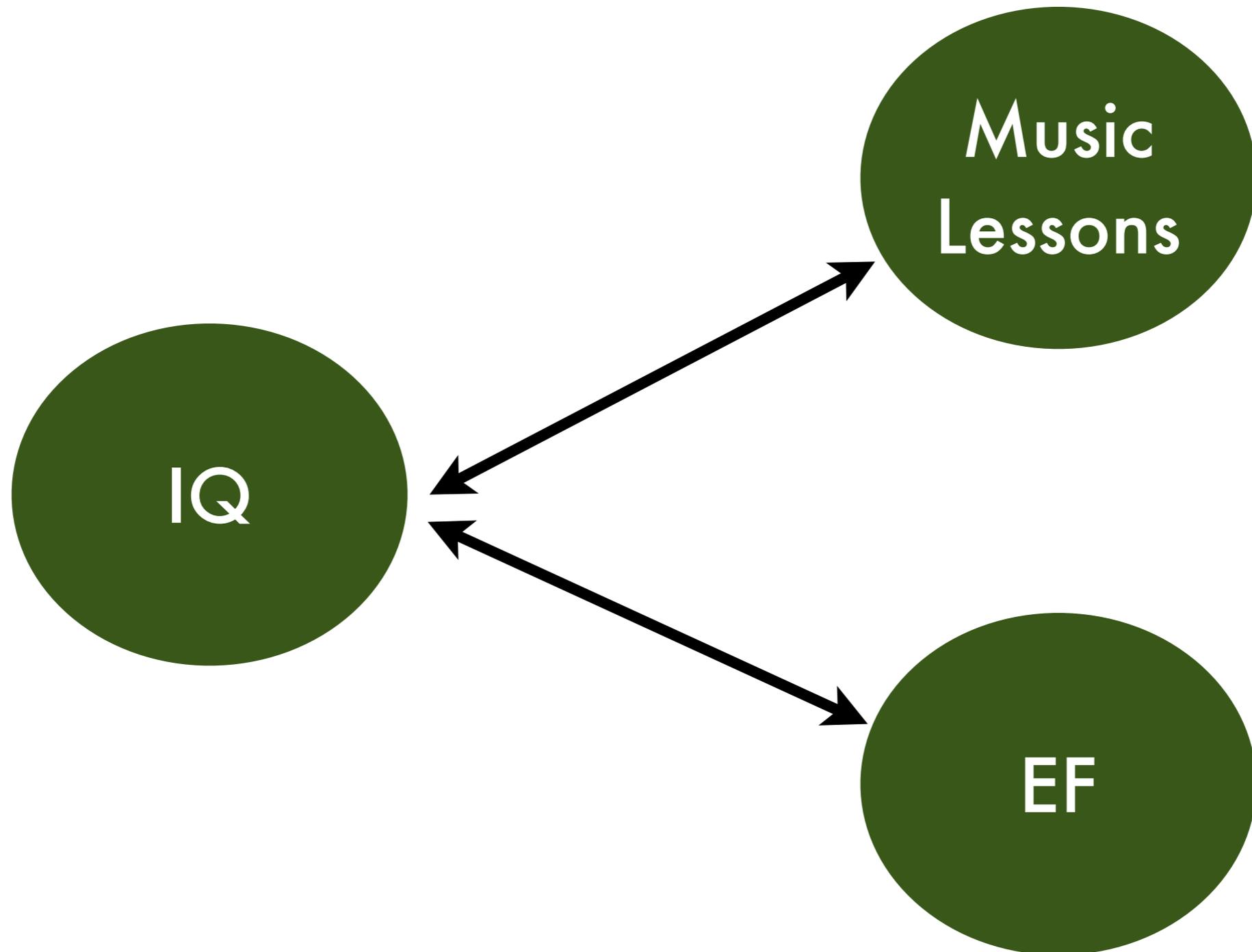
Music lessons, EF, & IQ

(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) Schellenberg, 2004, 2006
- What about emotional intelligence (EI/EQ)?

EI: Adults

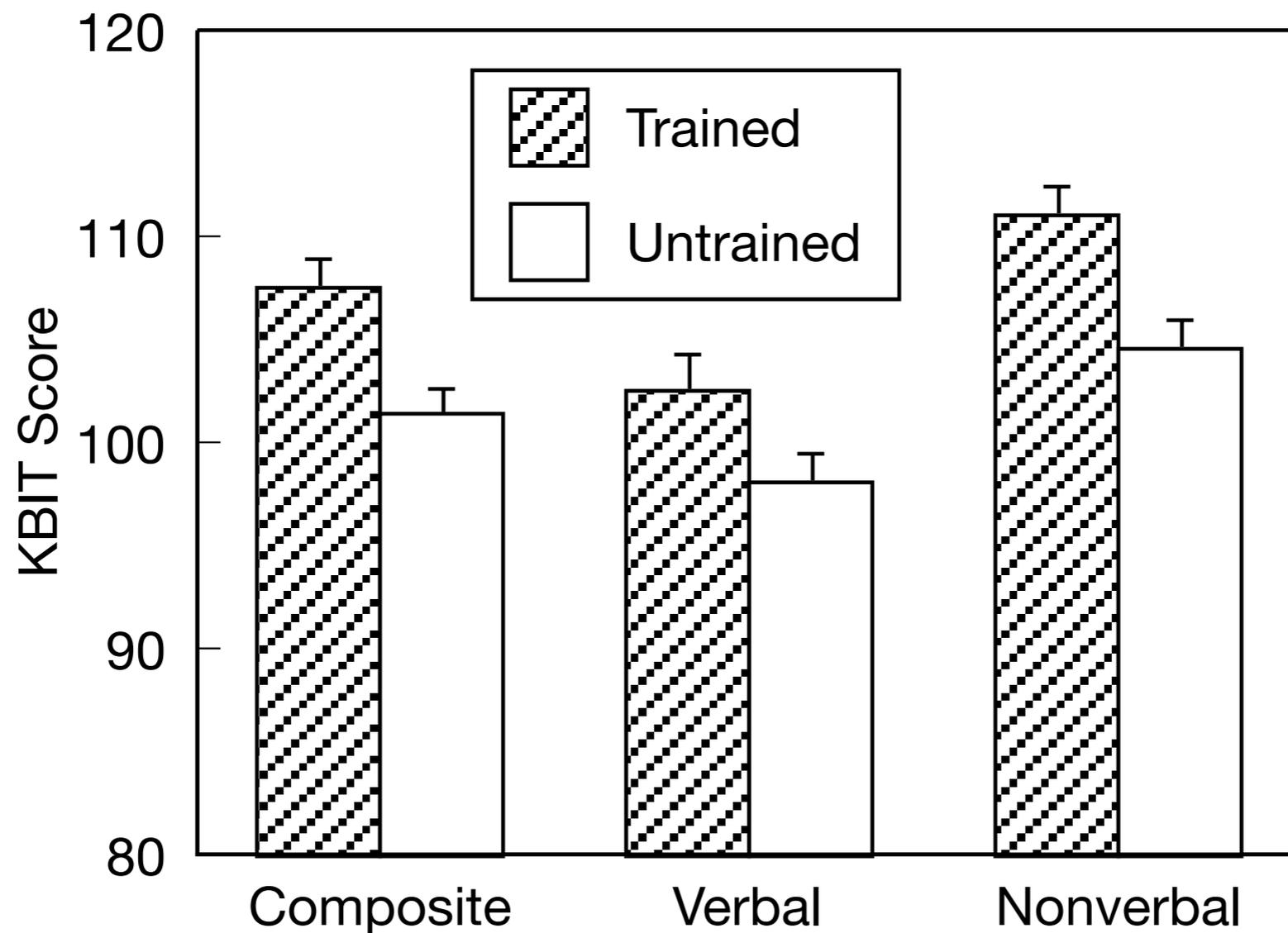
(Schellenberg, in press)

- Musically trained (≥ 8 years) and untrained adults
- Mayer-Salovey-Caruso Test of Emotional Intelligence (MSCEIT)
- Kaufman Brief Intelligence Test (K-BIT)

EI: Adults

(Schellenberg, in press)

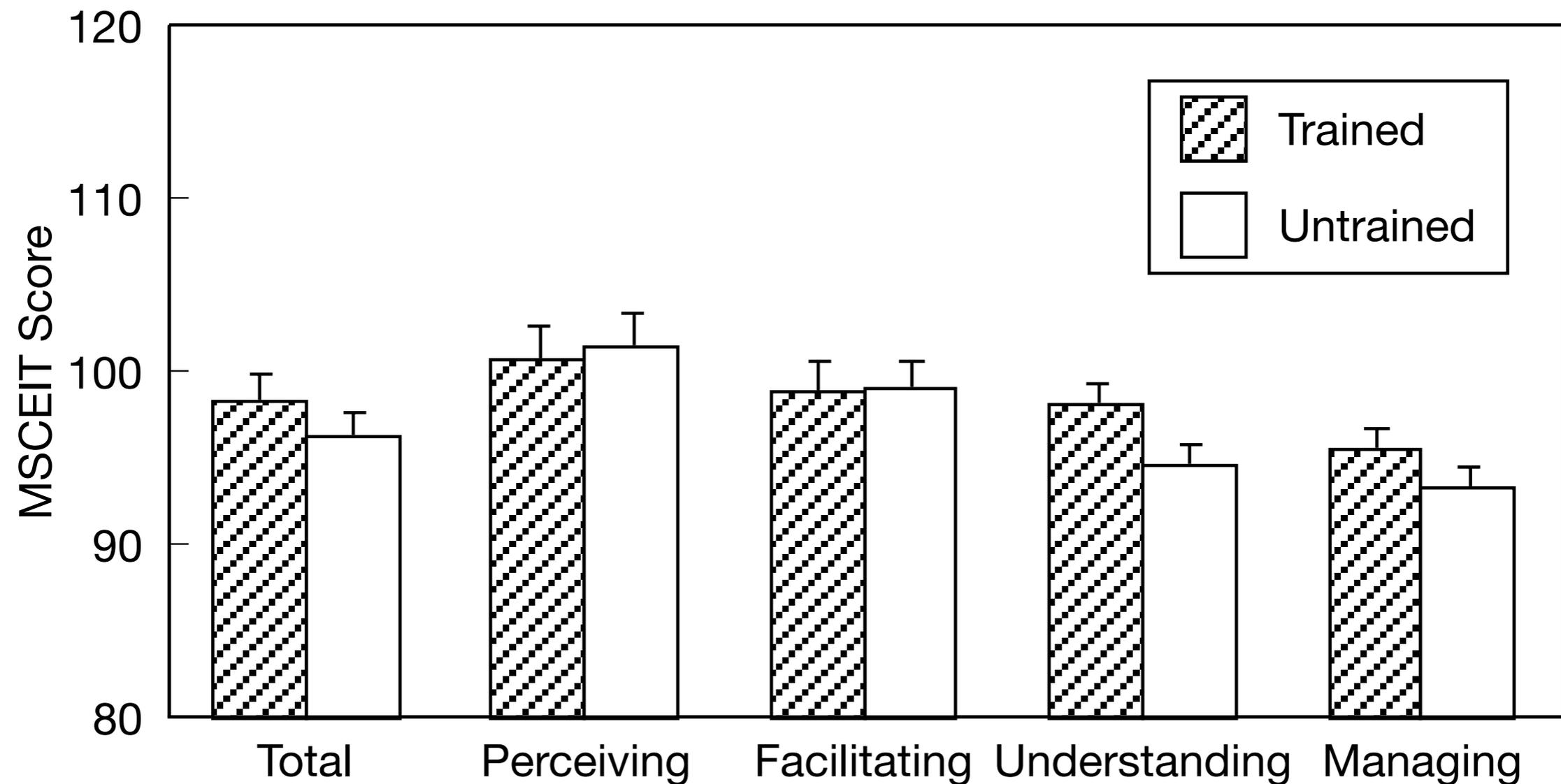
- Usual difference in IQ



EI: Adults

(Schellenberg, in press)

- No difference in EI



EI: Children

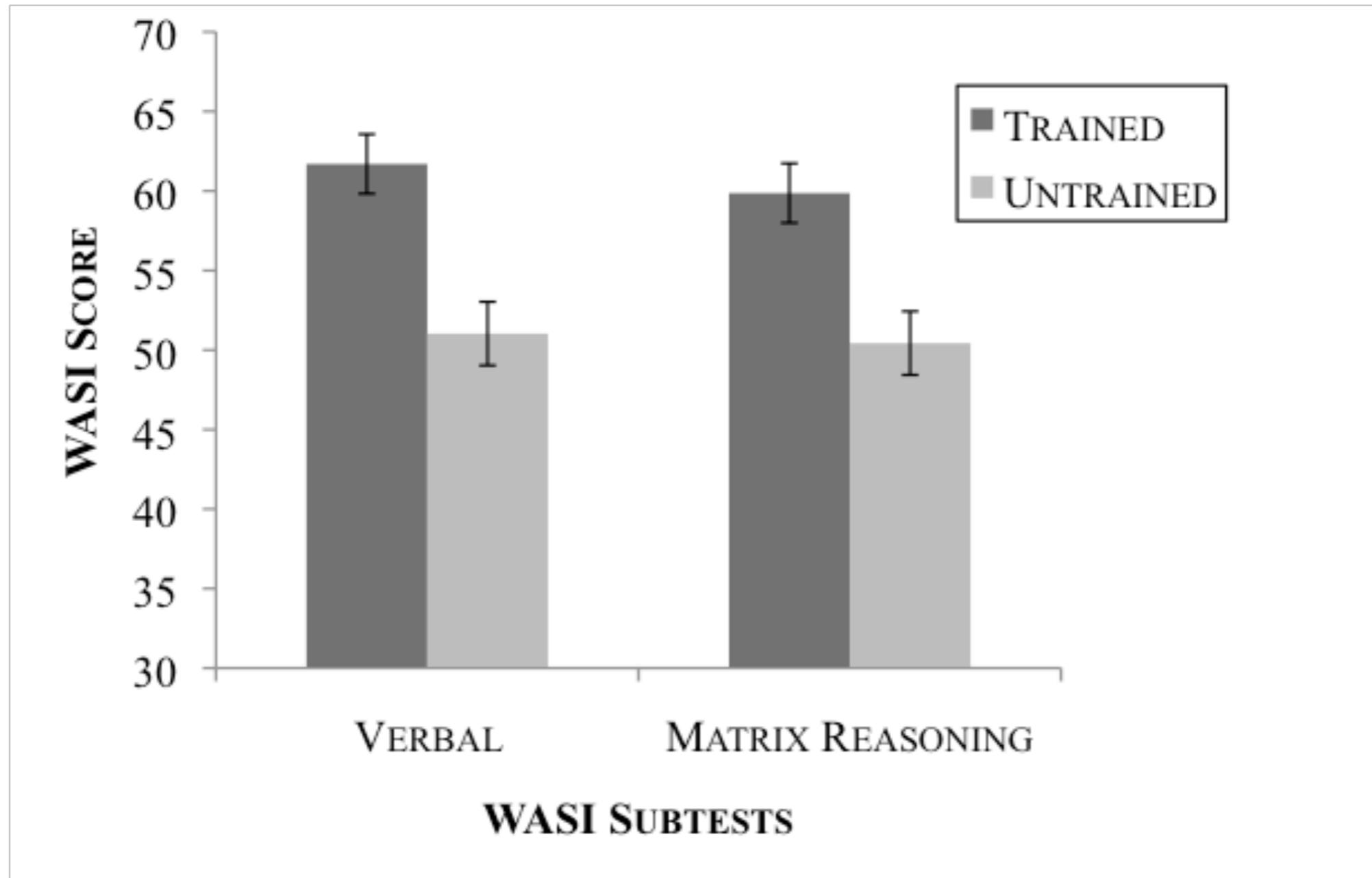
(Schellenberg & Mankarious, in preparation)

- 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)

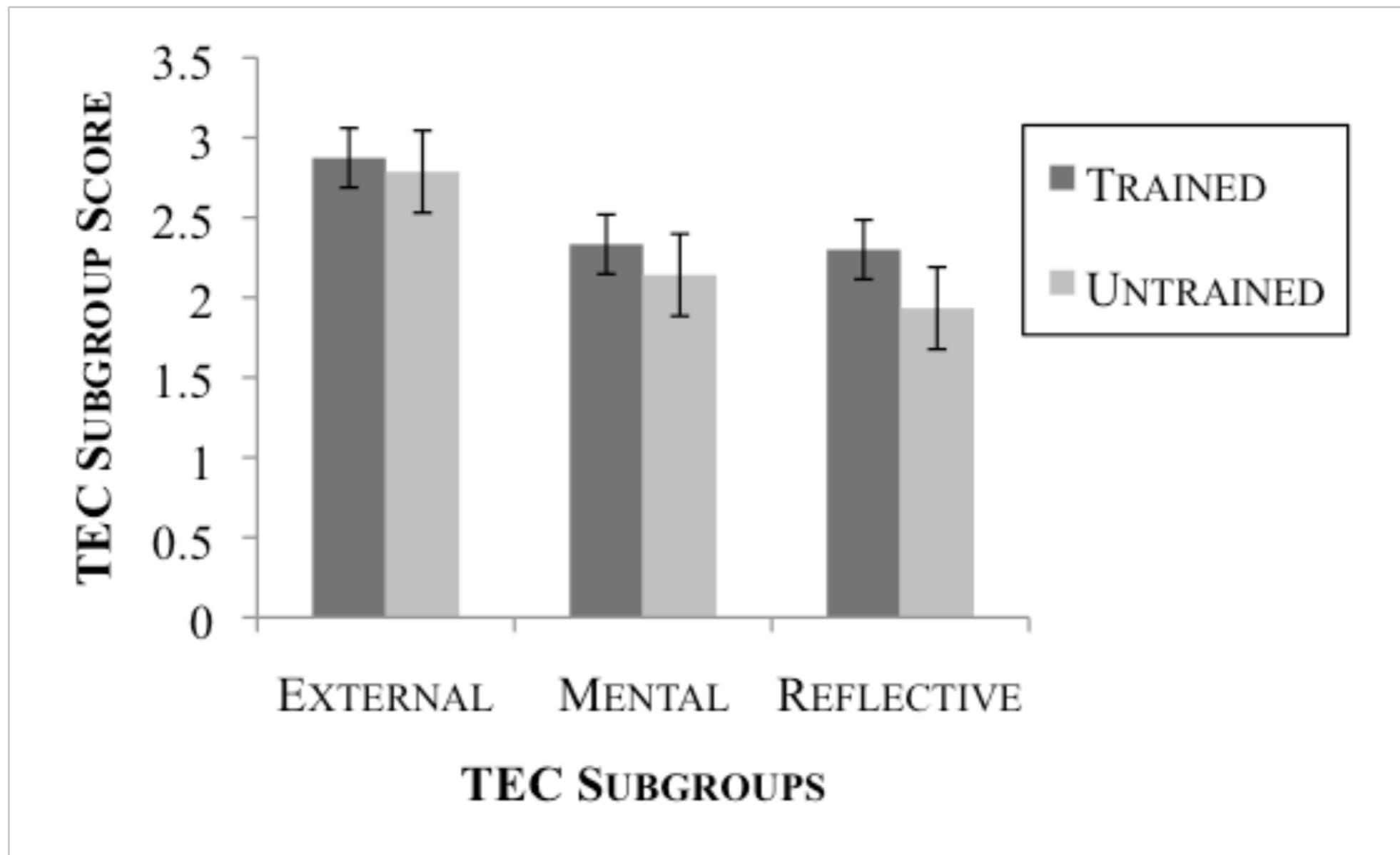
- Usual difference in IQ



EI: Children

(Schellenberg & Mankarious, in preparation)

- Trained children: Higher EI



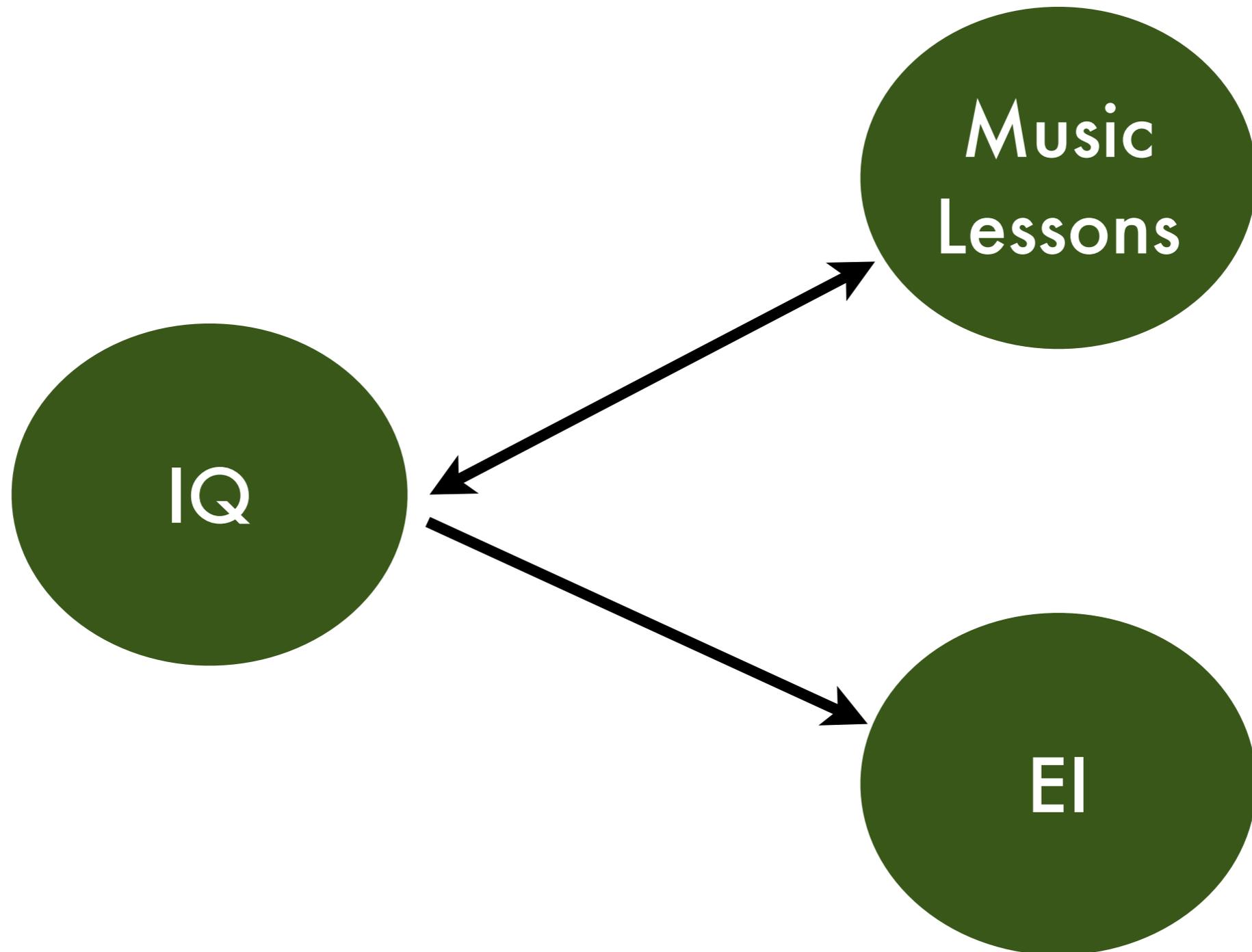
EI: Children

(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)

Causation & Neuroscience

- “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.

Causation & Neuroscience

- 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.

Causation & Neuroscience

- 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?