The structure of cognitive and musical abilities

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Simple Questions

- How do musical abilities fit in with other cognitive abilities (types of intelligence)?
- How does musical training affect musical abilities and general intelligence?

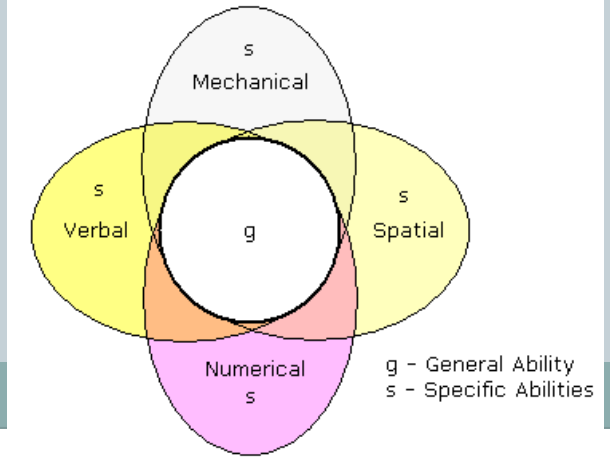
$\Rightarrow$ Answers from a model-based approach

Models of Intelligence

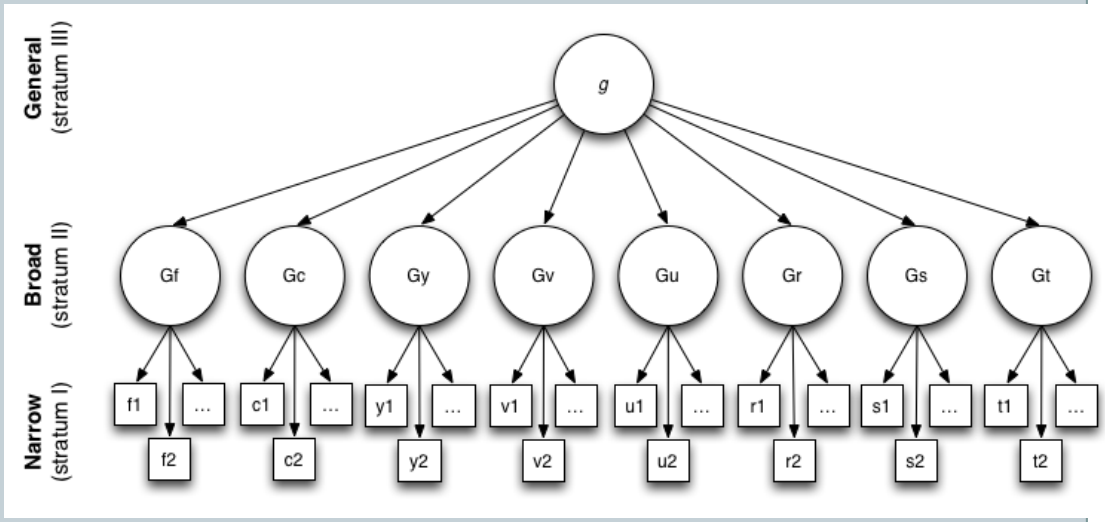
Hierarchical models

Spearman‘s model of g

	Classics	French	English	Math	Pitch	Music
Classics	-					
French	.83	-				
English	.78	.67	-			
Math	.70	.67	.64	-		
Pitch discrimination	.66	.65	.54	.45	-	
Music	.63	.57	.51	.51	.40	-
g	.958	.882	.803	.750	.673	.646

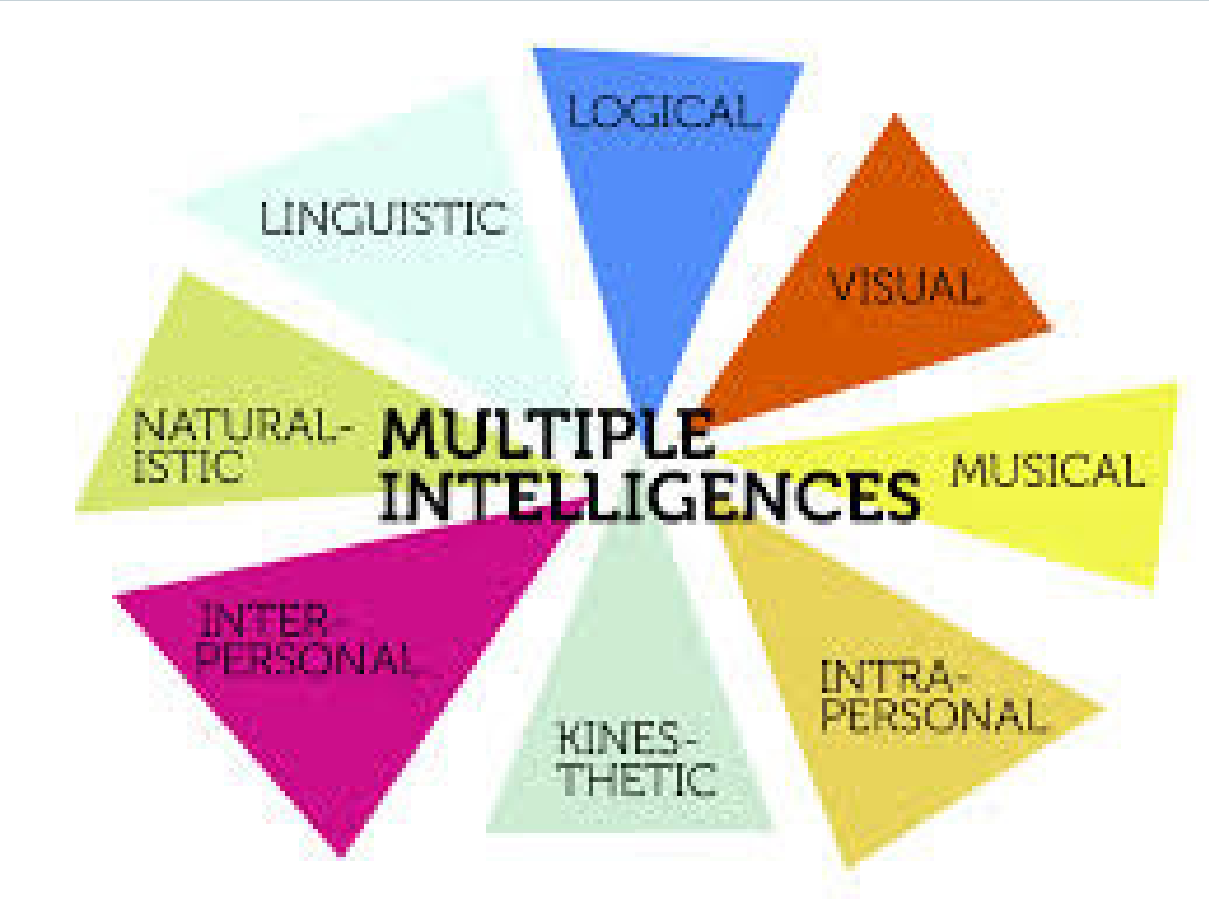


Carroll‘s 3-stratum model



Models of Intelligence

Gardner‘s Multiple Intelligences



Multiple independent intelligences

vs.

g

(hierarchical intelligence structure)

How do musical abilities fit in?

Music As Part of Intelligence Models

- Visser et al. (2006):
  - Adult sample
  - 8 types of intelligence (16 tests)
  - Music: Rhythm and Tonal scores from Gordon‘s AMMA
  - ⇒ Better support for hierarchical intelligence model
  - ⇒ BUT: Music tests have lowest loadings on g factor
- Castejon et al. (2010)
  - Children sample
  - 8 types of intelligence (tests from MI educational platform)
  - Music: Subjective teacher assessment
  - ⇒ Better support for hierarchical intelligence model
  - ⇒ Music scores: moderate loadings on g factors

Does Music Training Increase Intelligence?

- Correlational studies

  + Chen et al. (1998): verbal memory
  + Schellenberg (2006): IQ
  + Ruthsatz et al. (2008): g
  - Schellenberg & Moreno (2010): g
  + Schellenberg (2011): IQ
  + Hansen et al. (2012): verbal memory

  ....

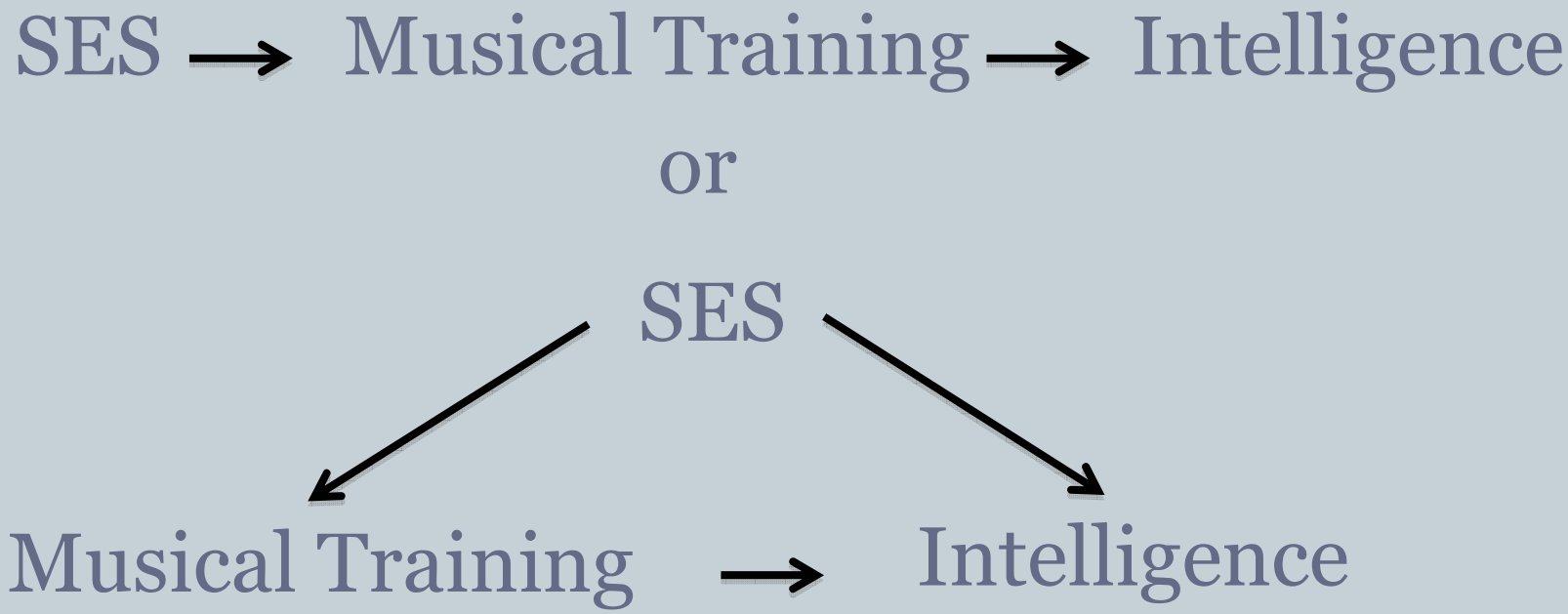
- Interventional studies

  - Costa-Giomi (1999): numerical, verbal, spatial abilities
  + Schellenberg (2004): Verbal and visusal intelligence
  + - Moreno et al. (2011): Verbal intelligence, but not spatial
  + Dege & Schwarzer (2011): Phonological awareness
  - Mehr et al. (2013): Spatial, numerical, visual vocabulary skills

Problems

- Potential confounders
  - Socio-economic status (SES, Corrigall et al., 2013)
  - Personality (Corrigall et al., 2013)
  - Self-concept (Dege et al., 2014)
  - Executive function (Dege et al, 2011)
  - …
- Measuring musical intelligence
  - Musical ability tests
  - Teacher assessment
  - Length / intensity of musical training or engagement

The Role of Socio-economic Status



Aims of Study

- Do musical abilities fit better with MI or hierarchcal model of intelligence?
  - Assess broader range of musical abilities with perceptual tests from Goldsmiths Musical Sophistication Index (Gold-MSI)
- How does musical training impact on musical abilities and other types of intelligence?
- How does SES affect musical training and intelligence?

Study

- Participants:
  - N=130, 64% women
  - Age = 26.2 years (SD = 10.2)
  - bias towards higher social classes and education levels
- Tests:
  - Wechsler Abbreviated Scale of Intelligence (WASI):
    - Verbal Intelligence: Vocabulary, Similarities
    - Perceptual Intelligence: Block design, Matrix reasoning
  - Gold-MSI perceptual tests:
    - Melodic memory
    - Beat perception
    - Sound similarity
  - Gold-MSI self-report scales, especially Musical Training
  - Socio-economic status (SES): NS-SEC

Correlations

	1.	2.	3.	4.	5.	6.	7.	8.
1. Musical Training	-							
2. Melodic Memory	.21	-						
3. Beat Perception	.40	.32	-					
4. Sound Similarity	.12	.12	.24	-				
5. WASI Vocabulary	.20	.23	.21	.15	-			
6. WASI Similarities	.32	.17	.33	.14	.59	-		
7. WASI Block Design	.22	.19	.24	.07	.36	.40	-	
8. WASI Matrix Reasoning	.28	.14	.26	.07	.36	.36	.47	-
9. Social Class	.19	.07	-.02	-.01	.28	.29	.04	.07

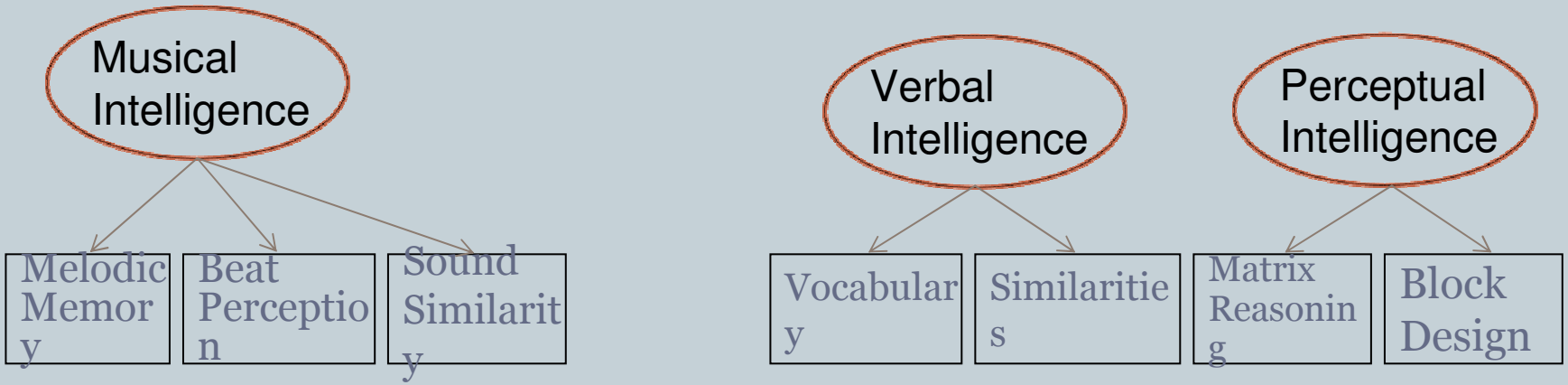
.05 uncorrected p-level ⇔ r = .18

Analytical Approach

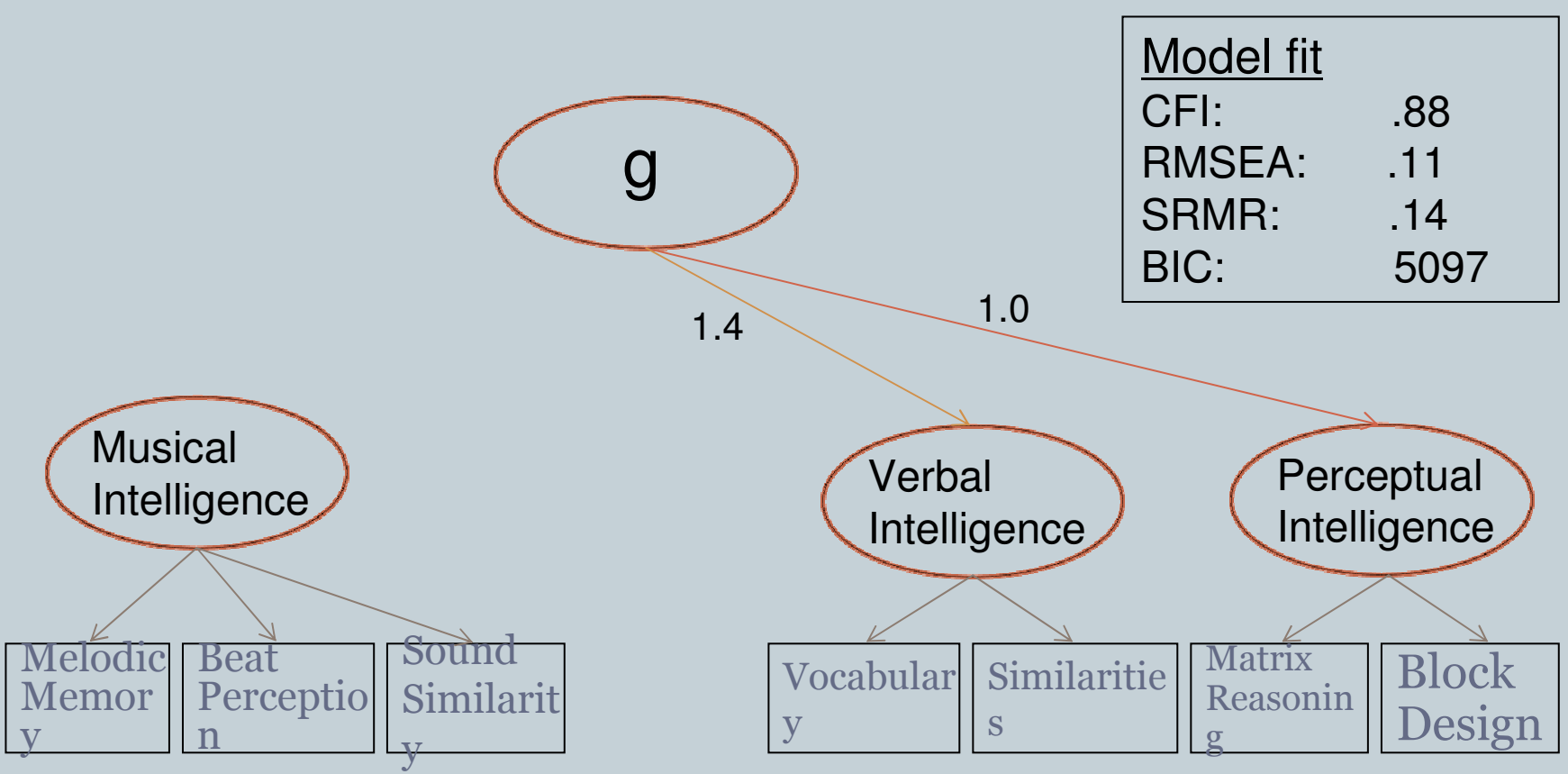
- Structural Equation Models
  - Handles many variables and multi-collinearity
  - Allows for hierachical models and latent variables
  - Direct and indirect effects (mediation)
  - Enables hypothesis testing of causal effects
  - Simple graphical representation (‚boxes and arrows‘)

1. Multiple independent intelligences

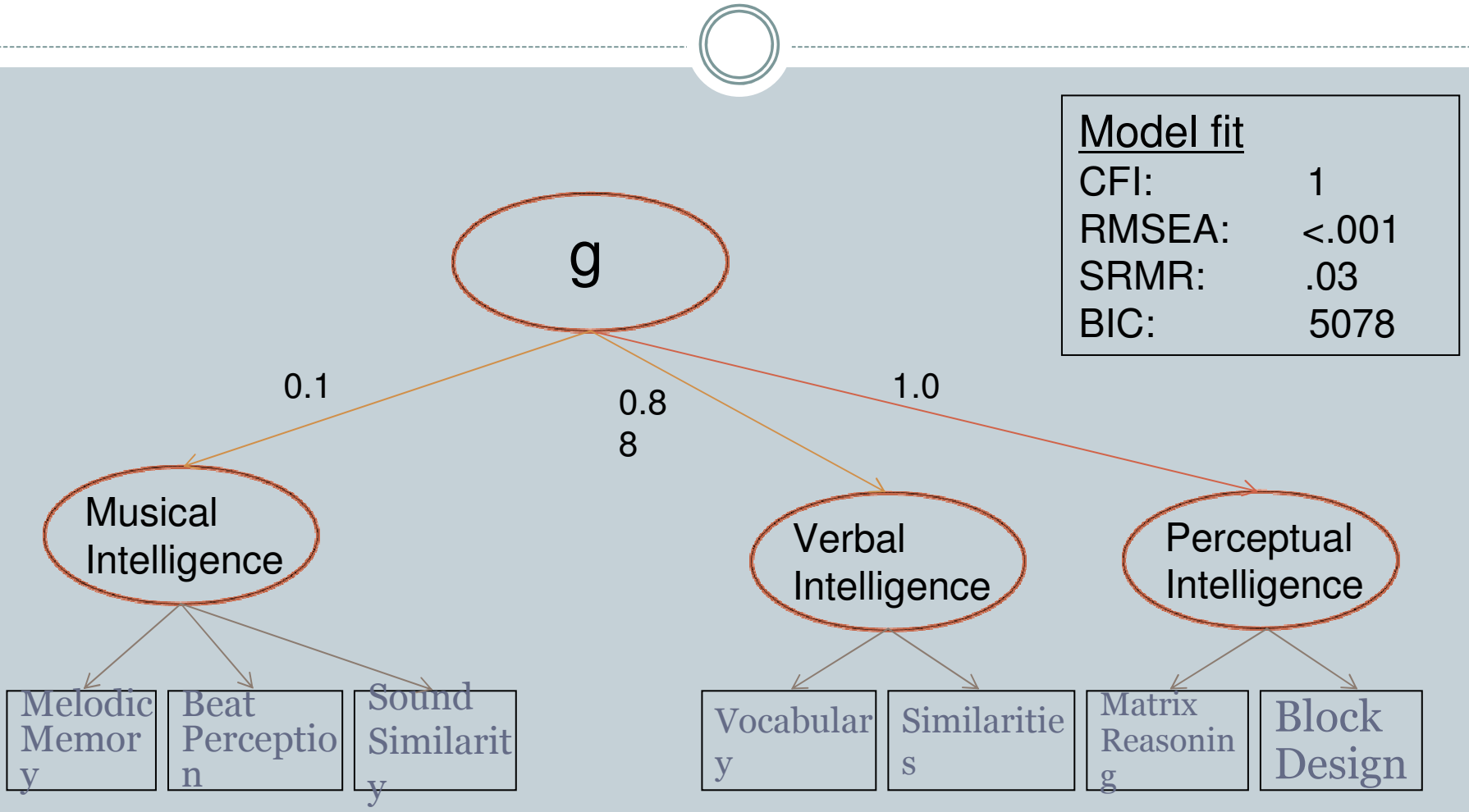
Model fit	
CFI:	.67
RMSEA:	.17
SRMR:	.20
BIC:	5121



2. Hierarchical intelligence, music separate



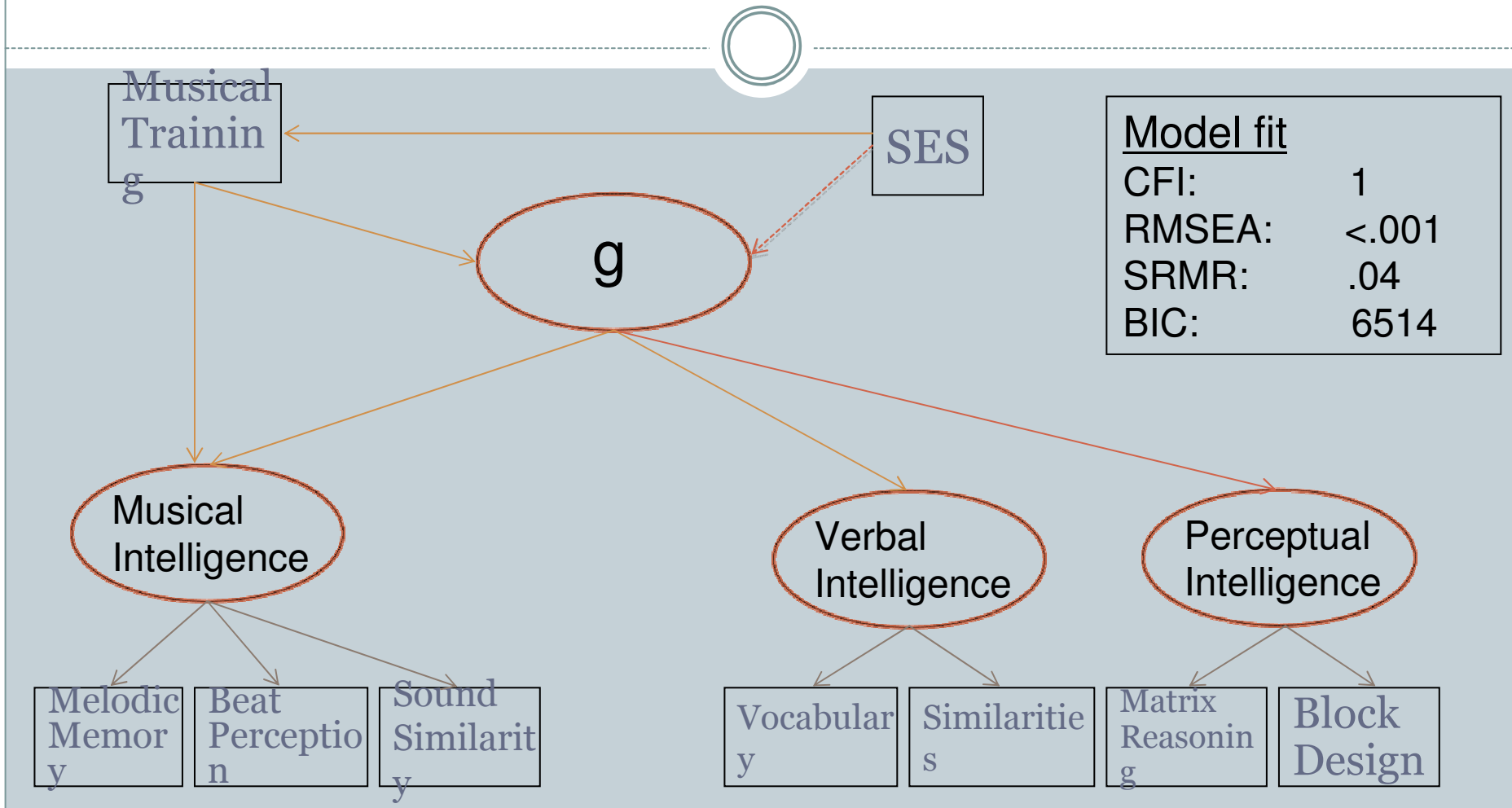
3. Full hierarchical model



Model comparisons

	DF	BIC	χ^2	p
Full hierarchical model	**11**	**5078**	**6.3**	**-**
Hierarchical, music separate	12	5097	30.3	<.001
Multiple intelligences	14	5121	64.3	<.001

Testing the Effects of Musical Training and SES



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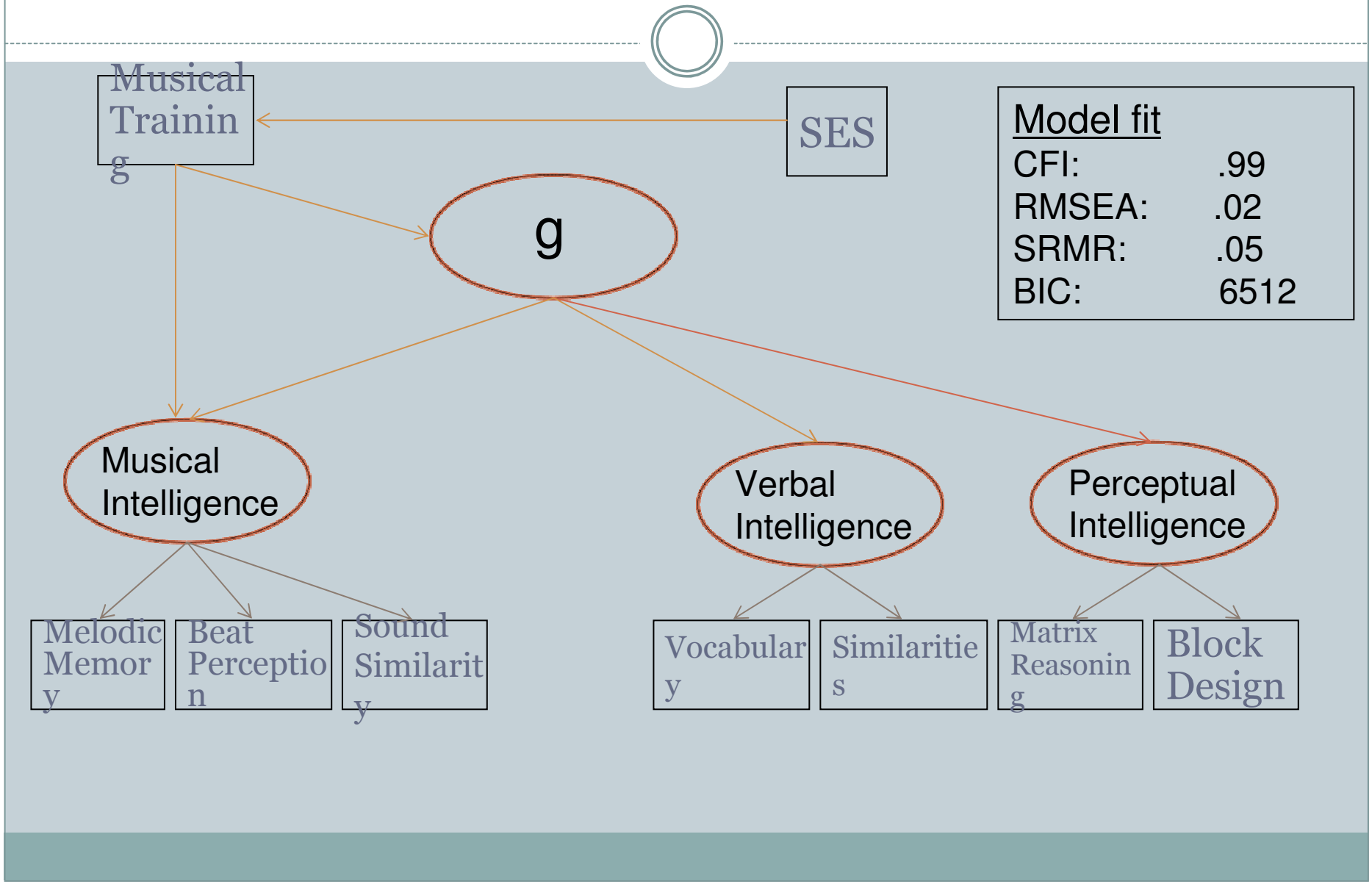

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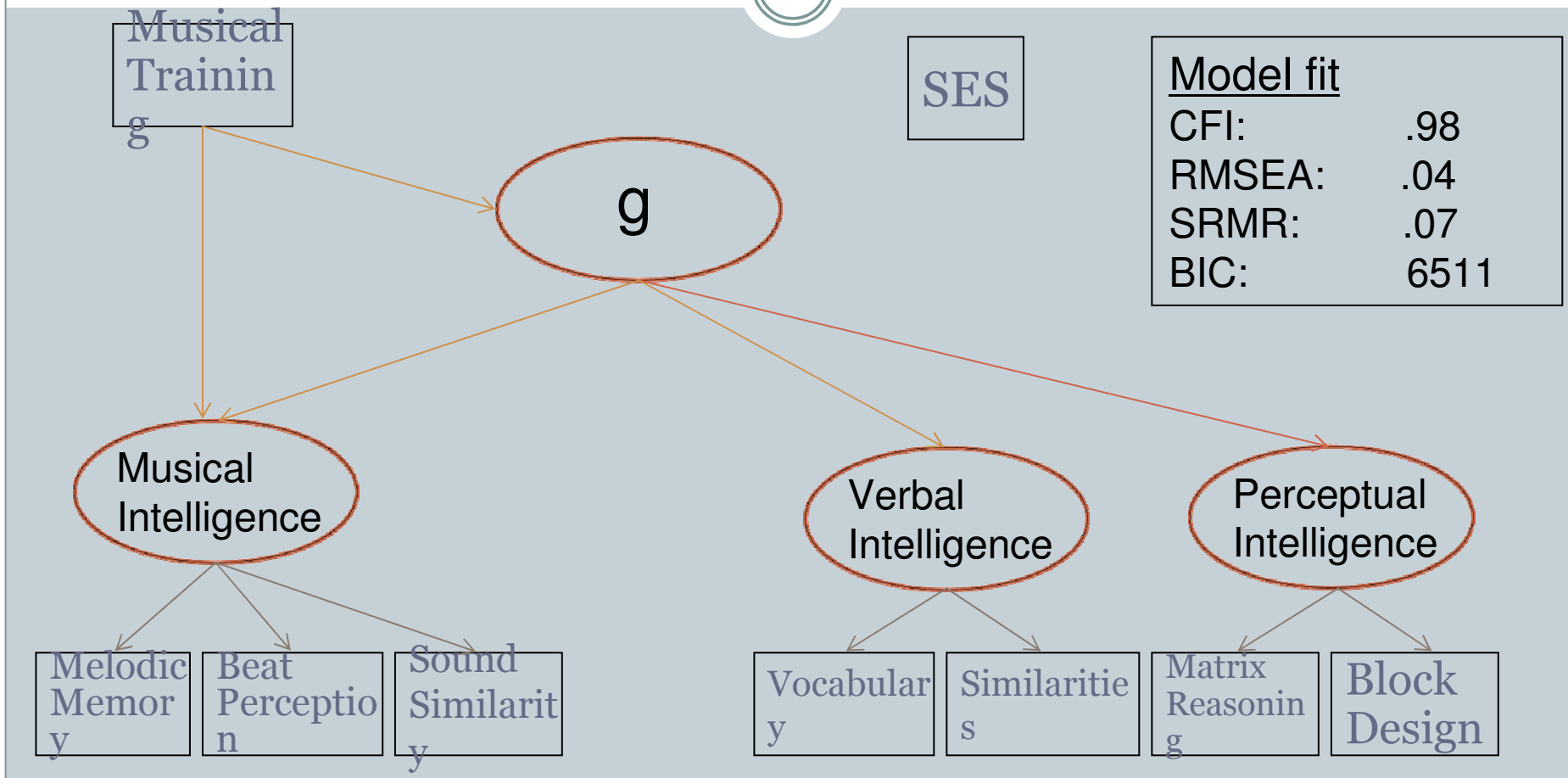
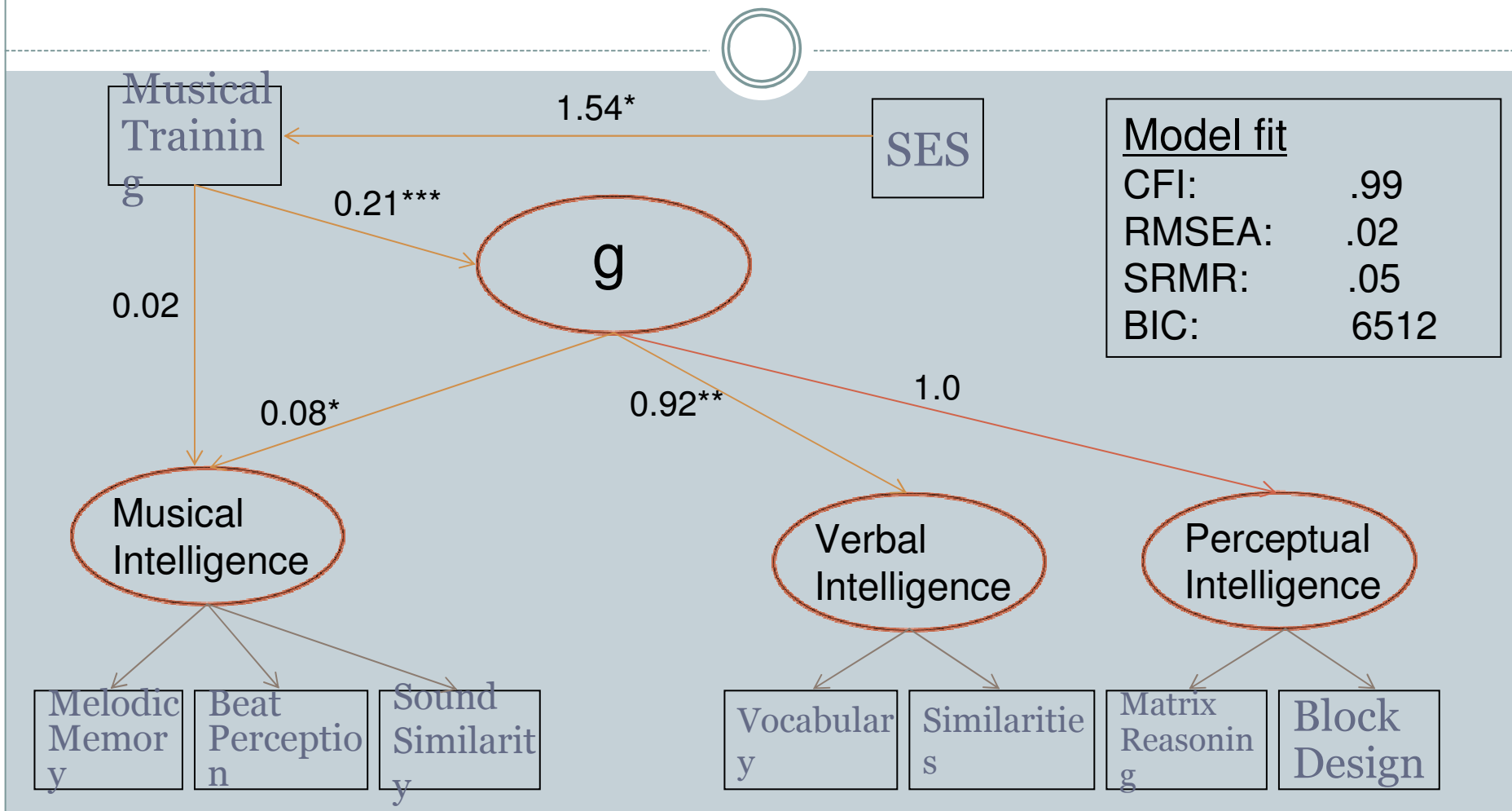


Model comparisons

	DF	BIC	χ^2	p
SES affecting g and MusTrn	22	6514	21.4	-
SES affecting only MusTrn	**23**	**6512**	**24.2**	**.09**
SES not affecting anything	24	6511	28.4	.04

Best Model


Musical Training
SES
1.54*
0.21***
g
0.02
0.08*
0.92**
1.0
Musical Intelligence
Verbal Intelligence
Perceptual Intelligence
Melodic Memory
Beat Perception
Sound Similarity
Vocabulary
Similarities
Matrix Reasoning
Block Design
Model fit
CFI: .99
RMSEA: .02
SRMR: .05
BIC: 6512

Summary

- Advantages of conceptualizing musical abilities in intelligence framework
- Musical perceptual abilities are best modeled within hierarchical intelligence model
  - But weaker connection than verbal and perceptual intelligence
- Musical training has positive effect on general intelligence
- Socio-economic status affects amount of musical training

Open Question: The arrow of causality
(e.g. Schellenberg, 2011)

Musical Training → Intelligence

Intelligence → Musical Training

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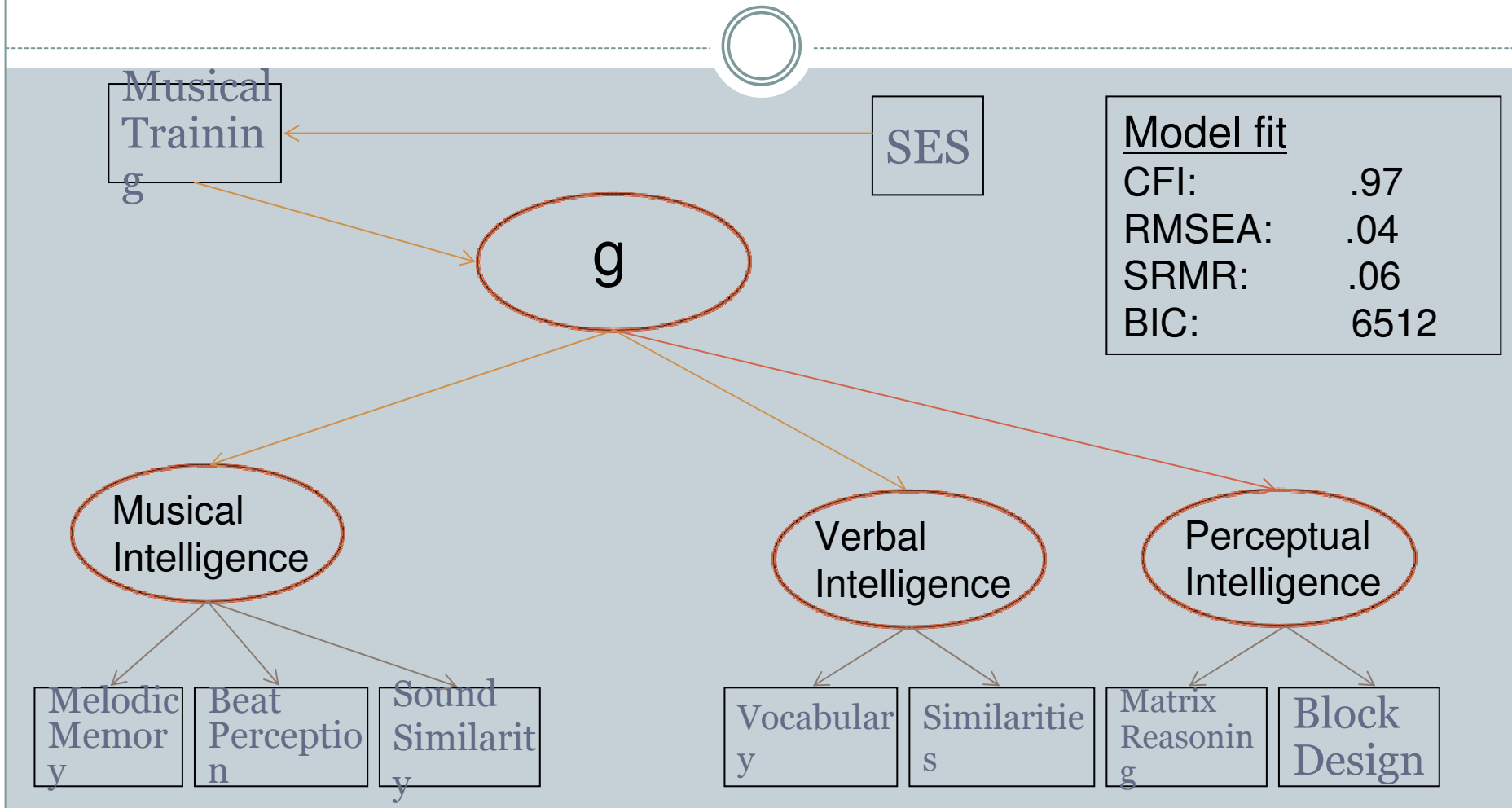

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