

Genetic influences on musical expertise - What do we know and what is missing?



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Outline

- **What do we know?**
 - Why do we think genes play a role?
 - How much do genes contribute?
 - Which genes?
- **What is still missing?**
 - Problems with gene finding
 - How to get there
 - Gene-environment interplay

Why do we think genes play a role?

- Universality
- Familial aggregation
- Variability in training hours among experts
- Genetic syndromes

How much do genes contribute quantitatively?

- Twin studies/Heritability
- **Self-reported measures of musicality**
 - Musical achievement: 20-38% (Coon and Carey, 1989)
 - Music accomplishment: 26% (Hambrick & Tucker-Drob, 2014)
 - Musical aptitude: 30-66% (Vinkhuyzen et al., 2009)
 - Exceptional musical talent: 86% (Vinkhuyzen et al., 2009)
 - Success in the music world: 9-57% (Mosing et al., 2015)

Large range and females somewhat lower than males

How much do genes contribute quantitatively?

▪ Objective measures of musicality

- Absolute Pitch (AP): suggestive (Theusch and Gitschier, 2011)
- Pitch processing: 80% (Drayna et al., 2001)
- Rhythm/melody/pitch discrimination: 12-59% (Ullén et al., 2014)
- Scale, out-of-key, and off-beat test: 3-50% (Seesjarvi et al., 2016)

How much do genes contribute quantitatively?

▪ Music practice

- Heritability of 38% and 70% for individual differences in music practice (Hambrick & Tucker-Drob, 2014; Mosing et al., 2014)
- Association between practice and music discrimination skills explained by shared genes (Mosing et al., 2014)
- Heritability of music accomplishment goes up with music practice (Hambrick & Tucker-Drob, 2014)

Which genes?

- Linkage analysis
- Association analysis
 - Candidate gene study (based on linkage and biology)
 - Genome wide association study (GWAS; hypothesis free)
- AP and music perception: chromosome 8q (Pulli et al., 2008; Theusch et al., 2009; Ukkola-Vuoti et al., 2013)
- Musical aptitude, pitch perception accuracy, composing, and pitch accuracy during singing: chromosome 4 (Oikkonen et al., 2015; Oikkonen et al., 2016; Park et al., 2012; Pulli et al., 2008)
- Music perception, music listening, and music memory: AVPR1A gene on chromosome 12q (Ukkola et al., 2009; Ukkola-Vuoti et al., 2011; Granot et al., 2007)
- Choir participation and music memory: SLC6A4 gene on chromosome 17 (Morley et al., 2012; Granot et al., 2007; Mariath et al., 2017)

Sounds very exciting, but...

What are we missing?

Genes

- Why are there problems with replication of gene-finding results?
 - Complex traits are influenced by **many genetic variants** of **very small effect** - difficult to detect using linkage analysis
 - large power needed also for candidate gene studies and GWAS - small sample sizes in music research
 - Difficulty in accurately measuring the traits in large cohorts (objective versus subjective)
 - Reliability of the measure (error)
 - Little interest in these traits

How to get there

- Very large sample sizes
 - Combined resources (consortia)
 - Online tests
 - Reliable/good measures
 - Universal measure
 - Harmonizing across measures
- If we have good online tests, we could make use of ongoing existing consortia efforts...

What else are we missing?

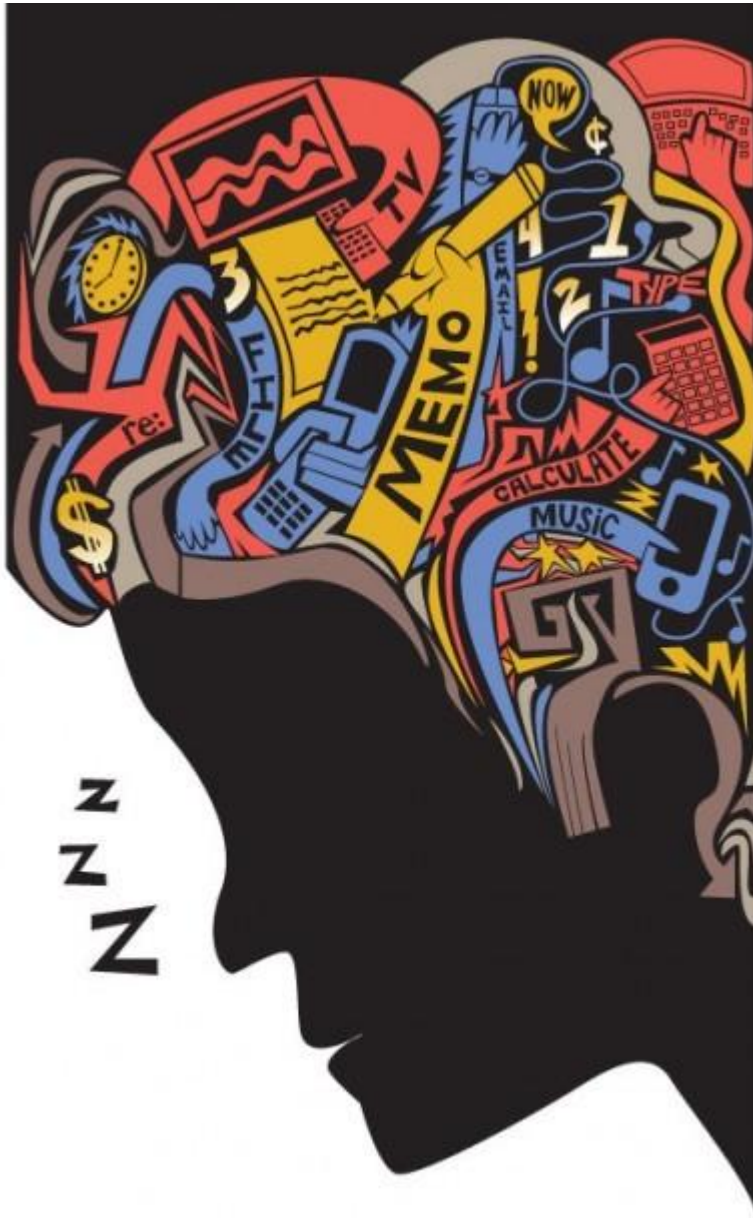
Gene-environment interplay

- Importance of both the environment AND genetic predisposition (talent)
- How do they interplay?
 - Gene-environment interaction (GxE)
 - The magnitude of the effect of an environmental factor depends on a person's genotype and vice versa.
 - Gene-environment correlation (rGE)
 - Passive GE correlation
 - Reactive GE correlation
 - Active GE correlation

Final words

- Genes and environment matter hugely
- We know a lot about the environment
- We know little about specific genes
- We know almost nothing about the interplay between G and E

...so there is lots to do!



**THE END
and
THANKS FOR
LISTENING**