ANBI 159: Biological and cultural perspectives on intelligence

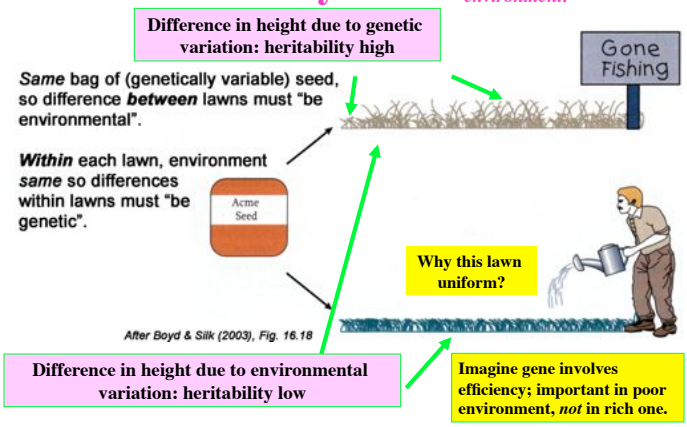
Lecture 23: Heritability and epigenesis of IQ

MIDTERM: will cover modules III and IV (all the readings in those modules; no questions on IV lecture topics I don't get to today)

http://weber.ucsd.edu/~jmoore/courses/

Genotype and phenotype - heritability

% variation in phenotype explained by variation in genotype *in that environment.*



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h^2 = % variation in phenotype explained by variation in genotype.

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h^2 *increases*. Why?

HERITABILITY - some figures

Twins reared together - IQ correlations:

Kinship:	Correlation:
MZ	.86
DZ	.60
Sib	.47
P-O	.42
Adopted sibs	.32

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P-O	.42	h^2 *increases* - all *but* MZ increase difference

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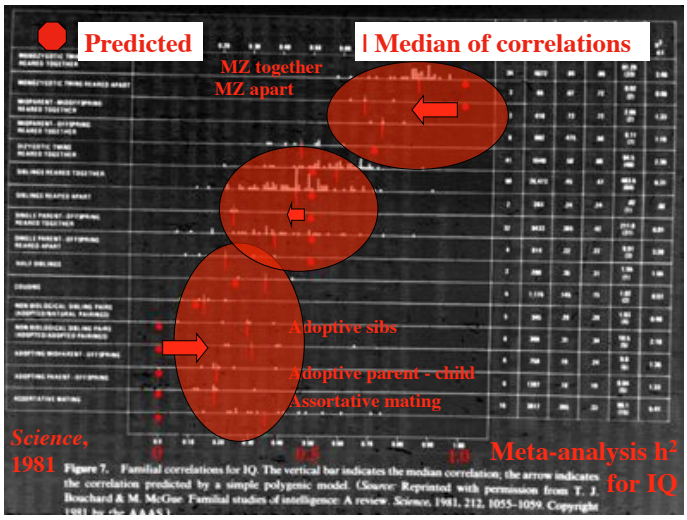
DZ	≈ .40	correlated placement? (niche picking - if *some* talent, seek appropriate environment)



Heritability of intelligence: an experiment

Lazlo Polgar: Hungarian vocational school teacher.

Argued existing school system too rigid, and that ages 3-6 are key years for education.

Decided to test educational ideas on his own children (3 daughters).

Intent: demonstrate his methods by educating them to genius-level excellence in 3 fields that are

1) thought to exemplify 'intelligence'
2) in which success/excellence can be measured

Math, foreign language, and chess

Ideals meet reality

Lazlo Polgar: Hungarian vocational school teacher.

But not wealthy, couldn't afford tutors in 3 fields, so all 3 educated to play chess - tournaments and competition totally unambiguous. NB: He *not* a chess player himself.

Saturate environment at home with chess: art on the walls, tabletops chessboards, large library entirely chess books; *everything*. All lessons organized around chess.

Polgar expt. - results.

Lazlo Polgar: Hungarian vocational school teacher.

Eldest daughter Zsusza started playing at 4, became international master at age 18.

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But they not the *real* hotshots...

Youngest, Judit, at age 15 became Grand Master and top-ranked woman player in the world.

Polgar expt. - results.

Lazlo Polgar: Hungarian vocational school teacher.

Demonstrates without doubt that (chess) genius can be created, environmental, and not *dependent* on inherited ability.

Was it a good idea? What would *you* need to know to decide?

Polgar expt. - results.

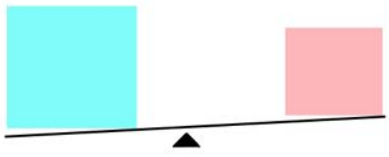
Lazlo Polgar: Hungarian vocational school teacher.

Ethical? Moral? Training as puppets, or educational breakthrough?

Google them & decide for self.

Laszlo, Zsusza, Zsofia, Judit Polgar

What does $h^2 = .4$ *mean*?



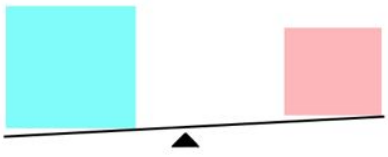
Popular interpretation:

Environmentally determined

What does $h^2 = .4$ *mean*?

Which is more important?

Environment.



Popular interpretation:

Environmentally determined

What does $h^2 = .4$ *mean*?

Population genetics interpretation:

Environment explains more variance than genes

What does $h^2 = .4$ *mean*?

Which is more important?

Environment has greater effect, but cannot separate them out

Population genetics interpretation:

Environment explains more variance than genes

What does $h^2 = .4$ *mean*?

Developmental (epigenetic) interpretation:

Environment explains more variance than genes

What does $h^2 = .4$ *mean*?

Which is greater?

Meaningless question.

Developmental (epigenetic) interpretation:

Environment explains more variance than genes

What does $h^2 = .4$ *mean*?

That genetic differences explain 40% of the variance in the trait, and enironmental differences explain the other 60%

and that "which is greater" is a meaningless question unless attached to a specific gene-environment developmental interaction.

So let's look at development and how it can go wrong...

Epigenesis by example

Normally, discussion of ontogeny of intelligence would get heavily into Piaget, developmental psychology.

So, we're going to do something quite different.

Epigenesis by example

Vision

Radiation

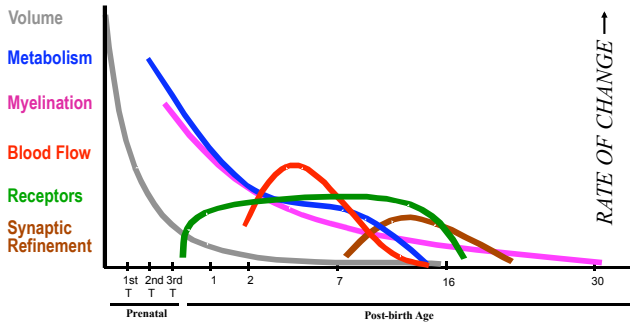
Lead

Alcohol

Cost to society

The overall goal is to illustrate *distinctions between "genetic" and "biological"* explanations for variation in intelligence.

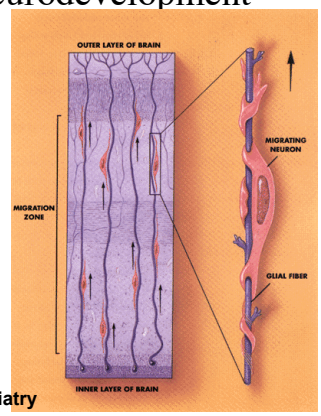
Brain Development



Slide by Dr. Bonnie Nagel, UCSD Psychiatry

Typical Prenatal Neurodevelopment

- Cell proliferation and migration
  - Supported by glial cells
  - Vulnerable to disruption
- Synaptic formation and myelination begin
- Blood brain barrier (BBB) not fully formed
  - Heightened vulnerability to toxins



Slide by Dr. Bonnie Nagel, UCSD Psychiatry

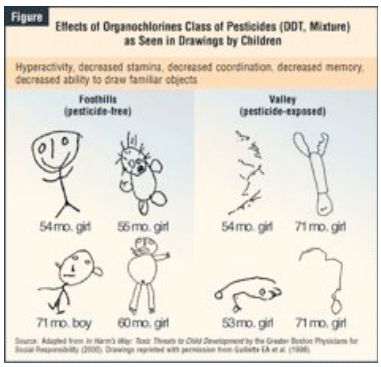
Not only are their brains still developing; kids are at greater risk

- Small size
- Increased metabolic rate
- BBB incomplete
- Put things in mouth
- More time on floors
  - Stir up and breathe dust and residues
- Consume relatively more fruit, juice, & water
  - Exposure to pesticides & contaminants

Modified from slide by Dr. Bonnie Nagel, UCSD Psychiatry

Pesticides

- Kids in Mexico who were & were NOT exposed to pesticides differ on Draw A Person:



Slide by Dr. Bonnie Nagel, UCSD Psychiatry

Relevance

- >75,000 chemicals manufactured since 1945
  - Less than 10% assessed for neurotoxic properties
  - "Innocent until proven guilty" regulatory policy
- 17% of U.S. children affected by developmental disabilities (CDC, 2003)
  - Rates increased in past decades
  - 28% may relate to exposure to toxins at some point during development

Slide by Dr. Bonnie Nagel, UCSD Psychiatry

Vision

What can go wrong?

Not just acuity (sharpness; e.g., 20/20):

Eye focusing
Eye coordination
Eye teaming (binocular vision)
Eye movement
Visual perceptual skills
Color vision

Variation in ability to easily focus or point the eyes or coordinate eye movements.

≈ 25% of children with *some* vision problem

Symptoms of vision problems include

- **difficulty following a line of print in a book or on a computer screen**
- **difficulty reading or doing homework for any length of time**
- **constantly look up and away from books or the computer**
- **frequently lose place when reading**
- **need to reread materials for comprehension**
- **headaches and pain in eyes after reading for a short time**
- **fidgetiness when doing close work**

Convergence insufficiency

Muscles of the eye responsible for convergence (turning the eyes in) appear to be weak, at least relative to the muscles responsible for divergence (turning the eyes out). Accommodating to reduce blur results in 'strained' eyes and the affected individual complains of

- **Headache,**
- **Eyestrain,**
- **Blurred vision, or**
- **Fatigue with continued efforts at near work.**

Most commonly in teenagers and young adults.

Vision & ADHD

Children with ADHD 3xnormal incidence of convergence insufficiency {normal 5% pop} - Dr. David Granet (UCSD)
ADHD inattentiveness, impulsiveness and hyperactivity.

Correlation not causation
Convergence insufficiency may be being misdiagnosed as ADHD, skewing the numbers.

ADHD may be causing the convergence insufficiency.

The same problem in the brain that causes ADHD may also cause convergence insufficiency.

The drugs that children take for ADHD may be causing convergence insufficiency.

Vision and intelligence

***Link is not direct, if it exists*: one method of diagnosing dyslexia is to compare reading test score with IQ, and if reading lower than expected, dyslexia -- i.e., makes use of *lack* of correlation.**

But think about what other aspects of life might be influenced by vision problems. Will return later in lecture...