Genes and Environment: Outline

Science isn't broken (but it's hard): Review & Discussion

Epigenetics

- Video review & discussion
- Diet can affect the epigenome
- Maternal behavior can affect the epigenome

Gene-environment interactions as reaction norms

- Childhood maltreatment & MAO-A (& replicability)

Epigenetics: How environment affects gene expression

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- **But some can get passed on to offspring. Why is that surprising?**

Epigenetics: How environment affects gene expression

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  Because those chemical flags are erased in the embryo (and in cells that will become sperm and egg cells) -- so they can make different cell types. But some apparently are not.

- **Can this process result in evolutionary change?**

Epigenetics: How environment affects gene expression

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- **Why does the speaker say it is more like "super duper early exposure?"**

Epigenetics: How environment affects gene expression

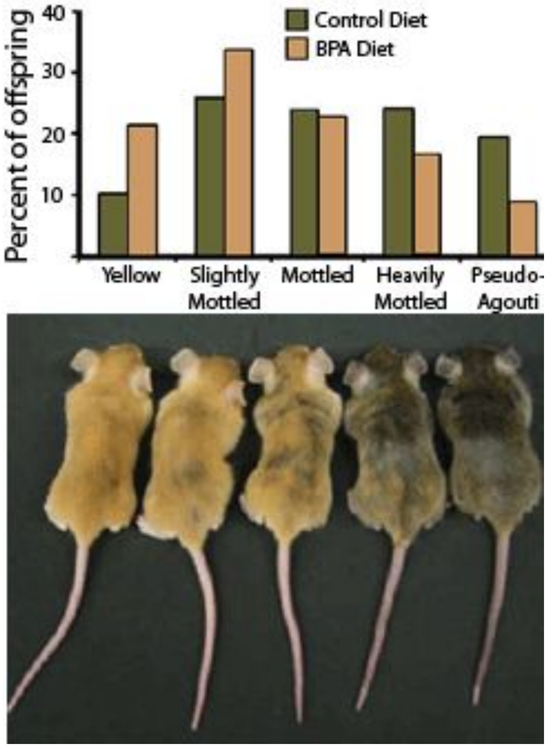
- **Can this process result in evolutionary change?** Evidence now is that it can affect children and grandchildren. But for evolution, would need to be preserved over many generations. No evidence for this.
- **Why does the speaker say it is more like "super duper early exposure?"** When the fetus is developing, its sperm and egg cells are already developing, so exposed to maternal environment.
- **Examples of epigenetic inheritance?**

Epigenetics: What you eat can affect your epigenome

- agouti mice carry gene that makes them ravenous, diabetic, yellow
- most offspring are like their parents
- unless fed “special diet” rich in methyl-donors (onions, garlic, beets)
- then they had the same gene, but looked brown and healthy

(from Randy Jirtle)

Epigenetics: So can chemical exposure



% of offspring showing trait was higher with BPA than control diet

Environmental influences early in development can affect gene expression throughout life

(from Randy Jirtle)

Epigenetics: Behavior affects the epigenome

Rats: lick your babies!

- nurturing moms (licked babies) > brave, calm babies
- neglectful moms (didn’t lick) > nervous, fearful babies

Meany & Szyf 2005; Weaver et al. 2004; 2005

Epigenetics: Behavior affects the epigenome

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Epigenetics: Behavior affects the epigenome

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- Effect reversed with cross-fostering
- Licking removed methylation on a gene that affects stress receptors (glucocorticoid receptor in hippocampus)
- Reversible in adults with methyl supplementation

Meany & Szyf 2005; Weaver et al. *Nat Neurosci* 2004; Weaver et al *J. Neuroscience* 2005

EP Question: Why are there “bad” rat mothers?

Why is “non-licking” behavior maintained in the population, not removed by natural selection?

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We think being anxious is a disadvantage, but in a food-scarce dangerous environment it might be helpful in finding food, avoiding predation.

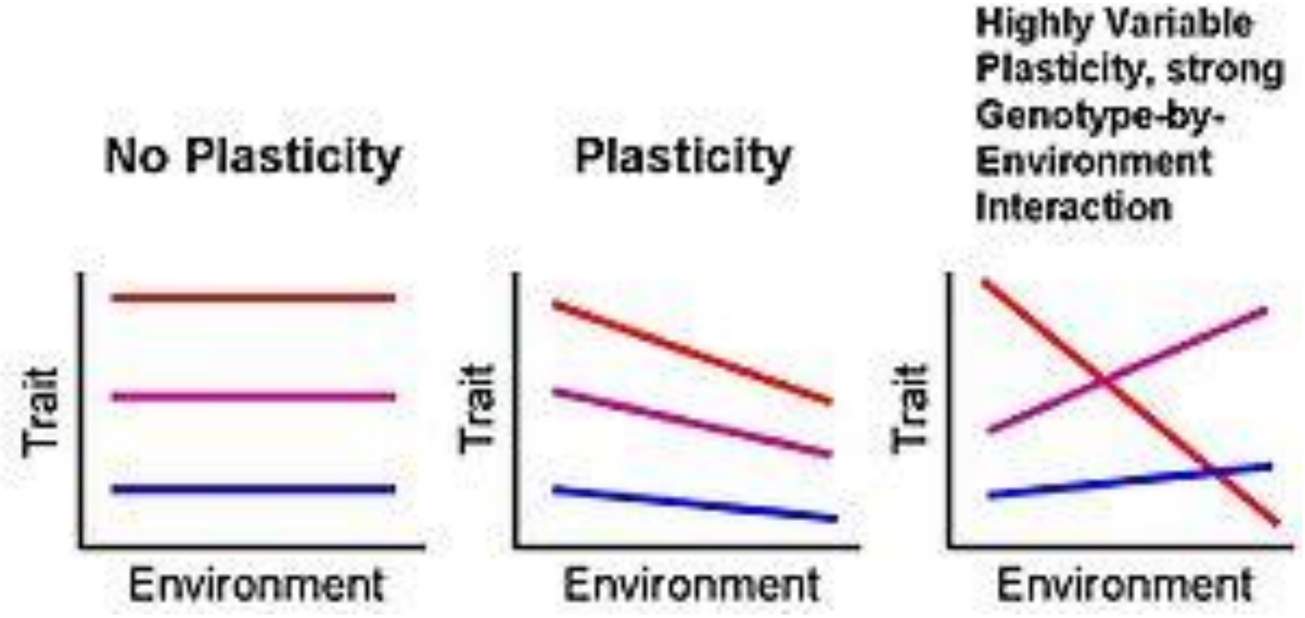
Epigenetic effects in humans: New data

Maternal stress and caregiving can affect methylation of genes related to stress & the immune system.

Maternal caregiving and DNA methylation in human infants and children: Systematic review. Provenzi et al. 2019. *Genes, Brain & Behavior.*

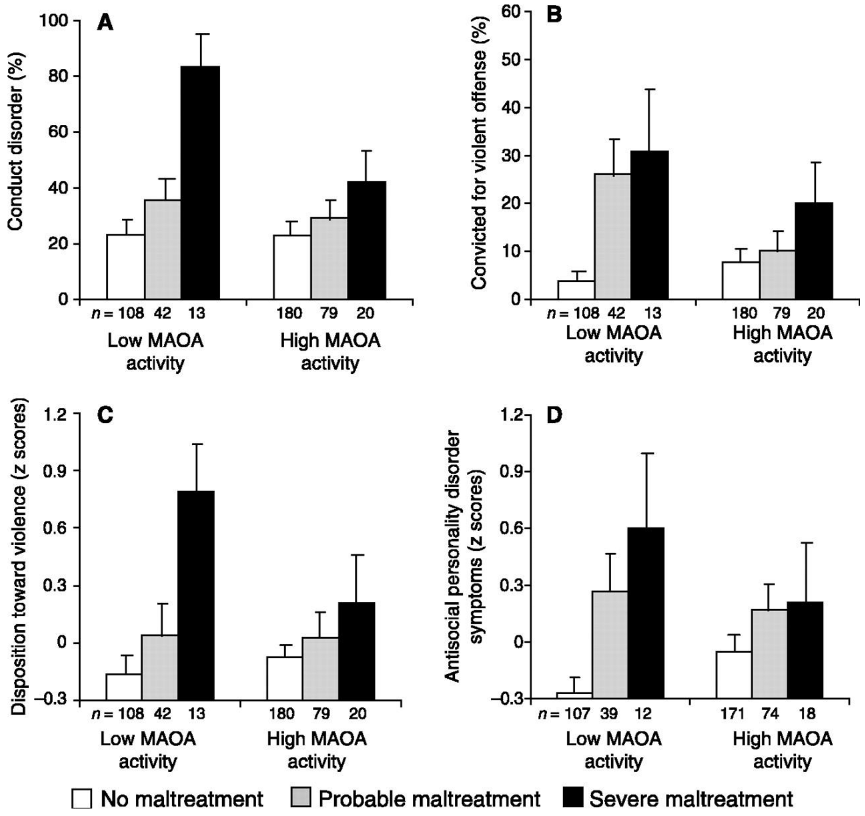
Adverse childhood experiences, epigenetics and telomere length variation in childhood and beyond: a systematic review of the literature. Lang et al. 2019. *European Child & Adolescent Psychiatry.*

Reaction norms & gene-environment interaction



Examples?

A gene-environment interaction?



Maltreatment > more antisocial behavior…

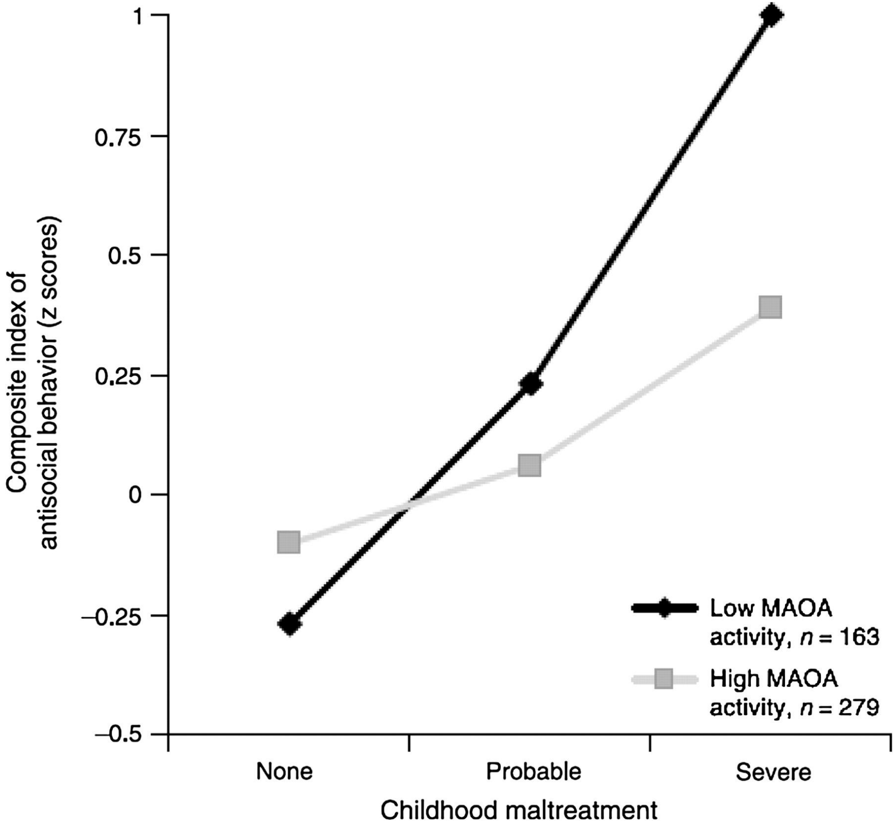
Especially with low MAO-A genotype. But...

Effect slightly reversed in homes with no maltreatment ?

Note: Many replications and non-replications of this early study

Caspi et al. 2002

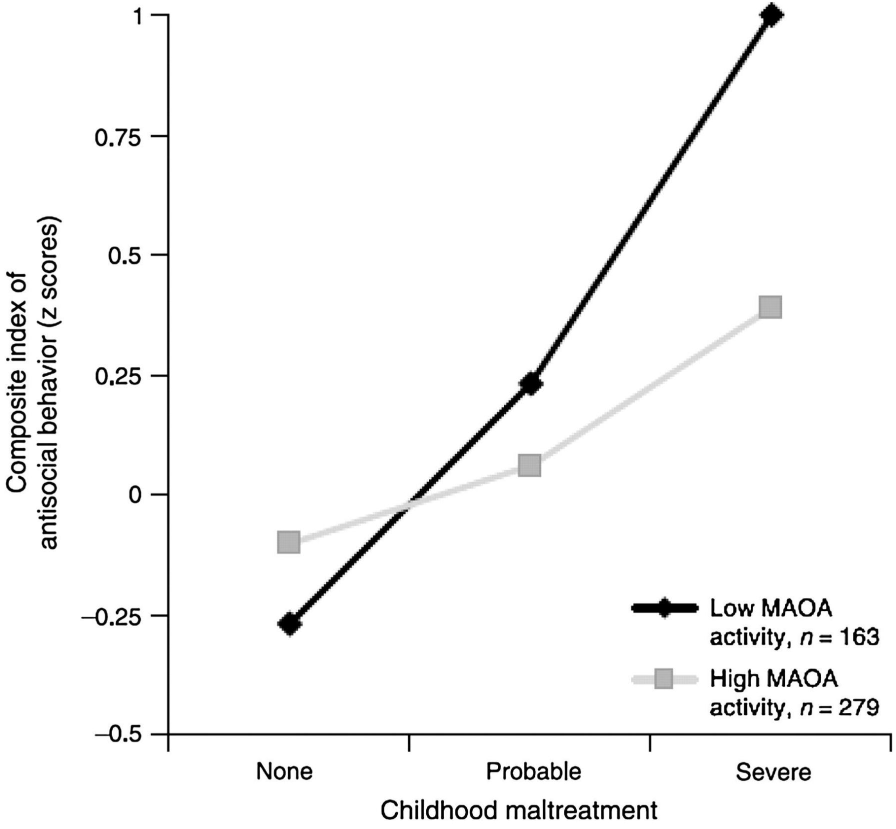
Same data, as two reaction norms



“Orchids” vs “Dandelions”

(Differential susceptibility can be expressed as reaction norms.)

Same data, as two reaction norms



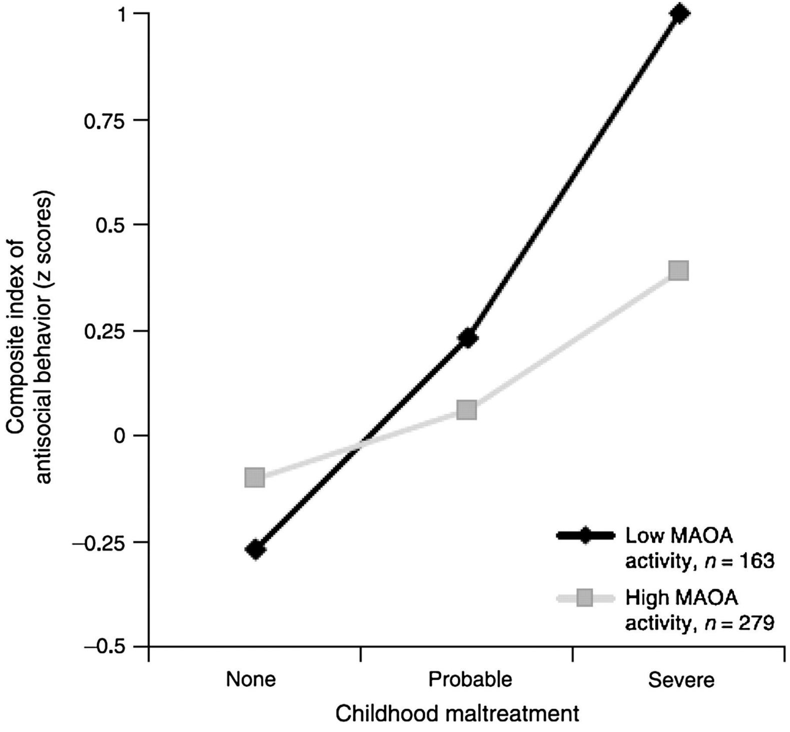
"Orchids" vs "Dandelions"

(Differential susceptibility can be expressed as reaction norms.)

Methylation at MAO-A region contributes to the interaction

(Chechnita et al. 2020 *Behavioral Brain Research*)

Has it been replicated? (science is hard)



Result of 2014 meta-analysis:

In males: Mostly; early adversity predicts antisocial outcomes more for *low* MAOA genotype

In females: Maltreatment (not general adversity) may lead to antisocial outcomes more for *high* MAOA genotype (weak effect)

Byrd & Manuck, *Biological Psychiatry.* 2014

Optional: brief note on heritability

WHEN TALKING ABOUT AN INDIVIDUAL, cannot separate genetic & environmental effects

WHEN TALKING ABOUT A POPULATION, can separate the *variance in the population* due to genes and environment (and their interaction)

heritability = proportion of total phenotypic variance due to genetic variance.