

PSYC3016: Developmental Psychology

Lectures 3 & 4: Behavioural Genetics

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Behavioural Genetics

Overview

Lecture 3:

- Heritability estimates
- Twin studies
- Types of environment

Lecture 4:

- The missing heritability problem!
- Interactions
- Why, as psychologists, do we care?

Behavioural Genetics

Learning Outcomes

Lecture 3:

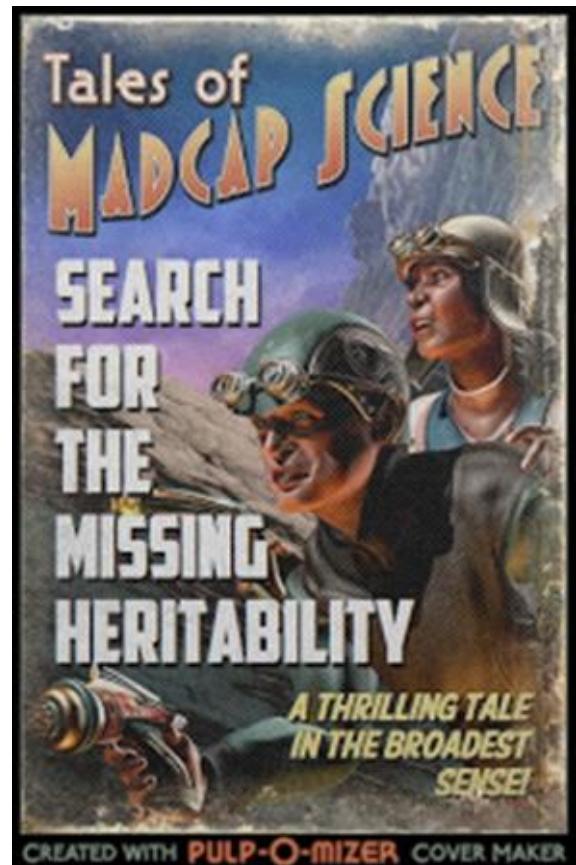
- LO1 – how genetic and environmental variables can shape development
- LO2 – understand the benefits and limitations of twin study designs
- LO3 – understand how to interpret results from behavioural genetic twin studies
- LO4 – understand how data obtained from behavioural genetic twin studies can inform understanding of child psychopathology

Lecture 4:

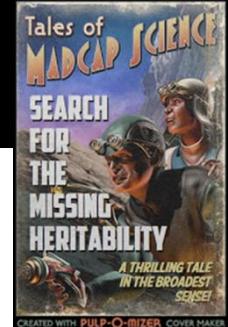
- LO1 – understand the missing heritability problem and what challenges this creates for understanding the mechanisms to explain child development.
- LO2 – be able to describe the theoretical and methodological reasons for missing heritability
- LO2 – be able to describe mediation and moderation interactions in the context of child development
- LO3 – understand the differential susceptibility hypothesis and how it can be demonstrated through gene-environment interaction analyses.
- LO4 – be able to critically evaluate the importance of understanding the relative roles of genes, the environment, and their interaction in public policy and psychological research.

The missing heritability problem

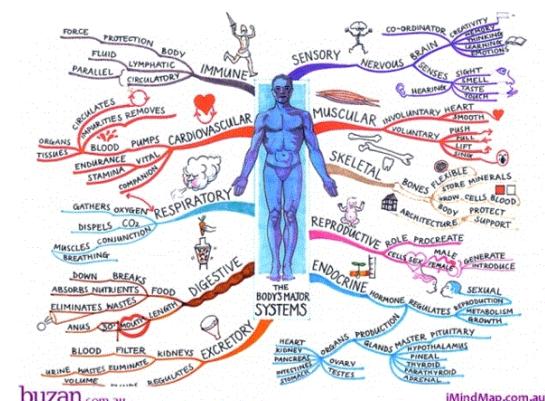
- What is the problem?
 - We know that all traits are heritable but finding the source of this heritability has remained elusive.
 - Replications of gene-disorder associations are rare, and even when they have been found, genome-wide studies indicate that only tiny proportions of the variance in diagnostic phenotypes are attributable to common genetic variations (Burmeister, McInnis, & Zollner, 2008).
 - This is annoying – we want to understand the origin of behaviours, traits etc.
 - So far, we have been fairly limited to working with shared, and unique, environmental variables, and with the few genotypes that have been found to be reliably associated



The missing heritability problem



- What could the reason be?
 1. We are not looking at the correct genes
- Hypothesis-driven research
 - The hypothesis is wrong or incomplete
- Functionality of the genes
 - The genes do not do what we think they do
 - The genes do what we think they do but so do lots of other genes (gene network, gene-gene interactions)
 - The proteins do not do what we think they do
- Relationship between protein function and biological function
 - The proteins do not do what we think they do
 - The proteins do what we thought they did but that does not influence brain function in the way we thought it did



The missing heritability problem

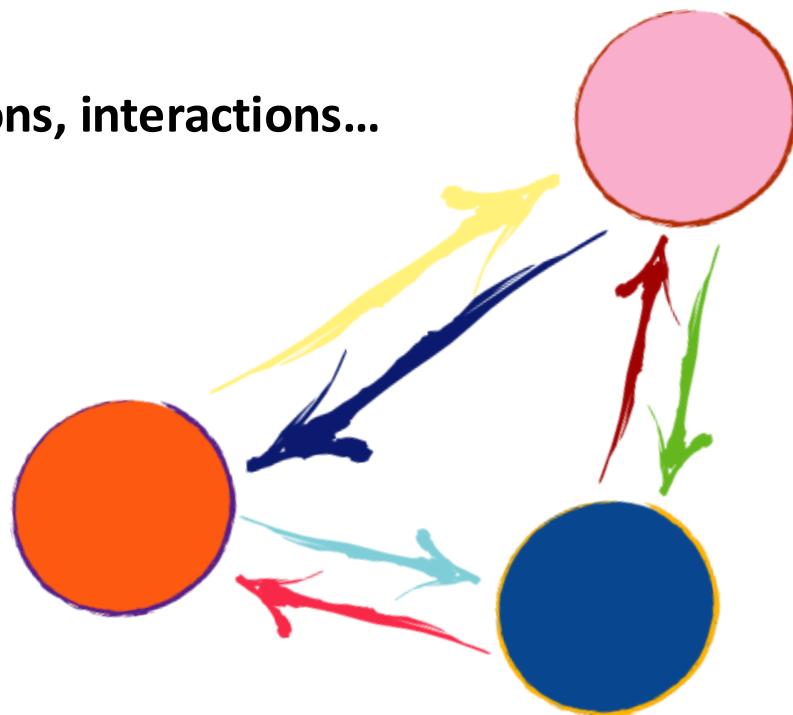
- What could the reason be?
2. We are not looking in the right samples
- Samples need to be as “pure” as possible
 - Overlap between phenotypes with different aetiologies (e.g. impulsivity, ADHD, executive control, traumatic brain injury)
 - Carefully describe the phenotype
 - Different distribution of genotypes in different ethnicities
 - Genotype-phenotype association in some ethnicities but not others
 - Range of descriptives too large
 - For a developmental disorder the phenotype may not be clear until a certain age (abnormal vs normal development)



The missing heritability problem

- What could the reason be?
3. We are not thinking about it in the right way
- We have already mentioned gene-gene interactions
 - Let's be a bit smarter...

Interactions, interactions, interactions...



The missing heritability problem

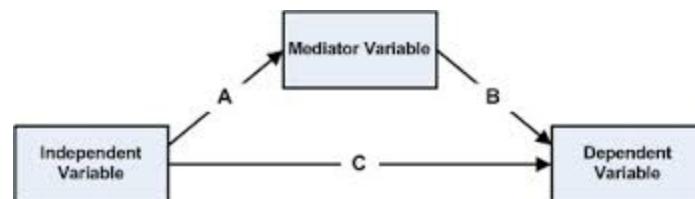
Interactions

What is an interaction?

- Where one variable influences the relationships between two other variables

Mediation:

- Mediator variables specify how or why a particular effect or relationship occurs.
- E.g. Time spent doing homework is associated with better exam performance but this is **mediated** by the time spent doing practice papers. (this is a made-up example!)
 - I.e. doing homework is only really associated with better examination performance because doing homework is associated with doing more practice papers. Doing practice papers is associated with better exam performance



The missing heritability problem

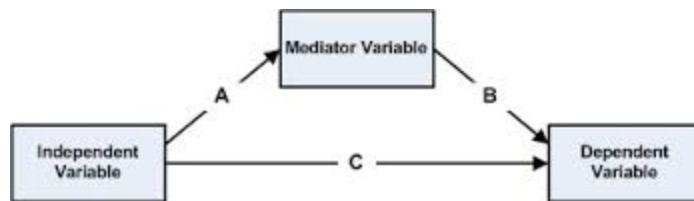
Interactions

Genetic interaction effects

Mediation: commonly referring to understanding the association between a genotype and phenotype

E.g. Serotonin 1B polymorphism associated with callous-unemotional traits (personality/behaviour)

- What mediates this relationship? What is the real reason for this relationship?
- The effect of serotonin neurotransmission in a particular brain region? The involvement of serotonin in basic cognitive and attention processes?



The missing heritability problem

Interactions

What is an interaction?

Moderation:

- A moderator variable changes the strength of an effect or relationship between two variables.
- Moderators indicate when or under what conditions a particular effect can be expected.
- A moderator may increase the strength of a relationship, decrease the strength of a relationship, or change the direction of a relationship.
 - E.g. there may be a positive association between revising and exam performance for time periods of less than 120 minutes per day. But for time periods of more than 120 minutes the relationship is negative.
(This is a made-up example!)

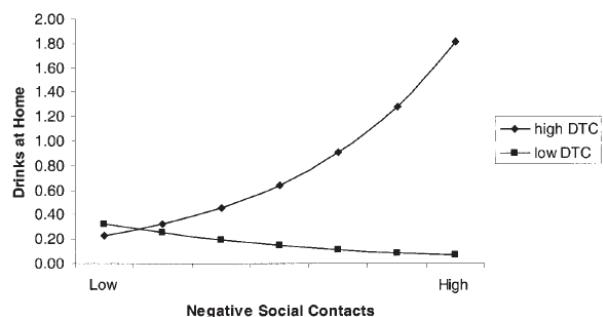


Figure 1. The interaction effect of drinking to cope (DTC) and negative social contacts on drinking at home.

The missing heritability problem

Interactions

Genetic interaction effects

Moderation: when a genotype (or genotypic effect) changes the relationship between an environmental independent variable and a dependent variable

- Can this answer important questions...?
- E.g. we know that child abuse and maltreatment is associated with adult psychopathology – but why not for everyone?

What is this?



Differential susceptibility

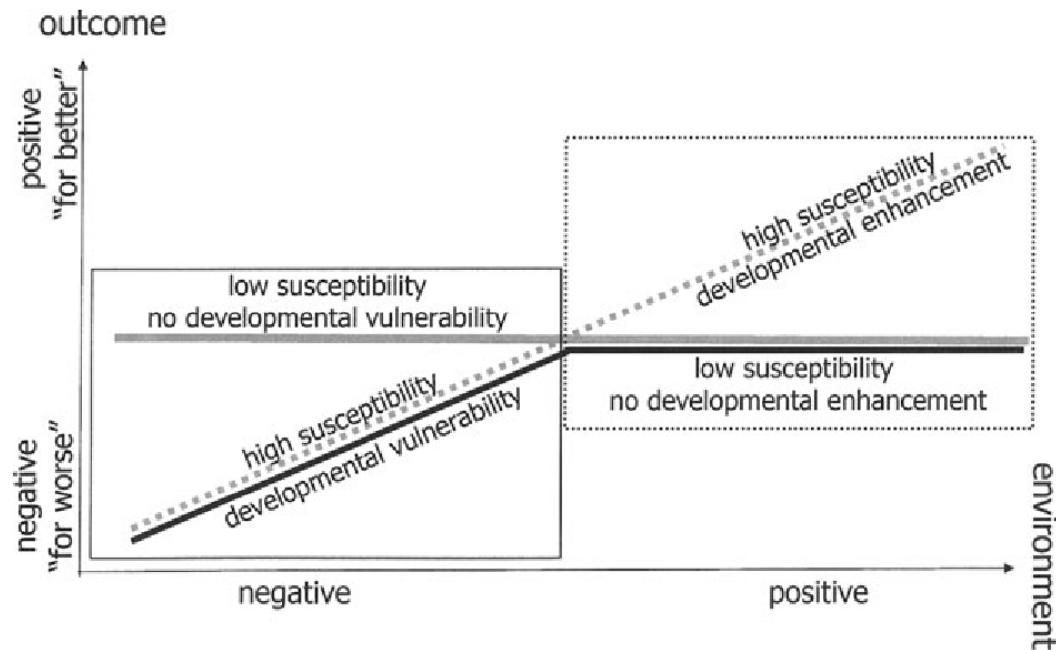
- You need to, at least for some important outcomes, take account of important genetic differences and parenting behaviours simultaneously – That is, you need to look at the **interaction**

The missing heritability problem

Interactions

- Ellis et al. (2011) Differential susceptibility to the environment: An evolutionary–neurodevelopmental theory, *Developmental Psychopathology*, 23, 7-28

This model says that the environment will have a different effect on you depending on how susceptible you are

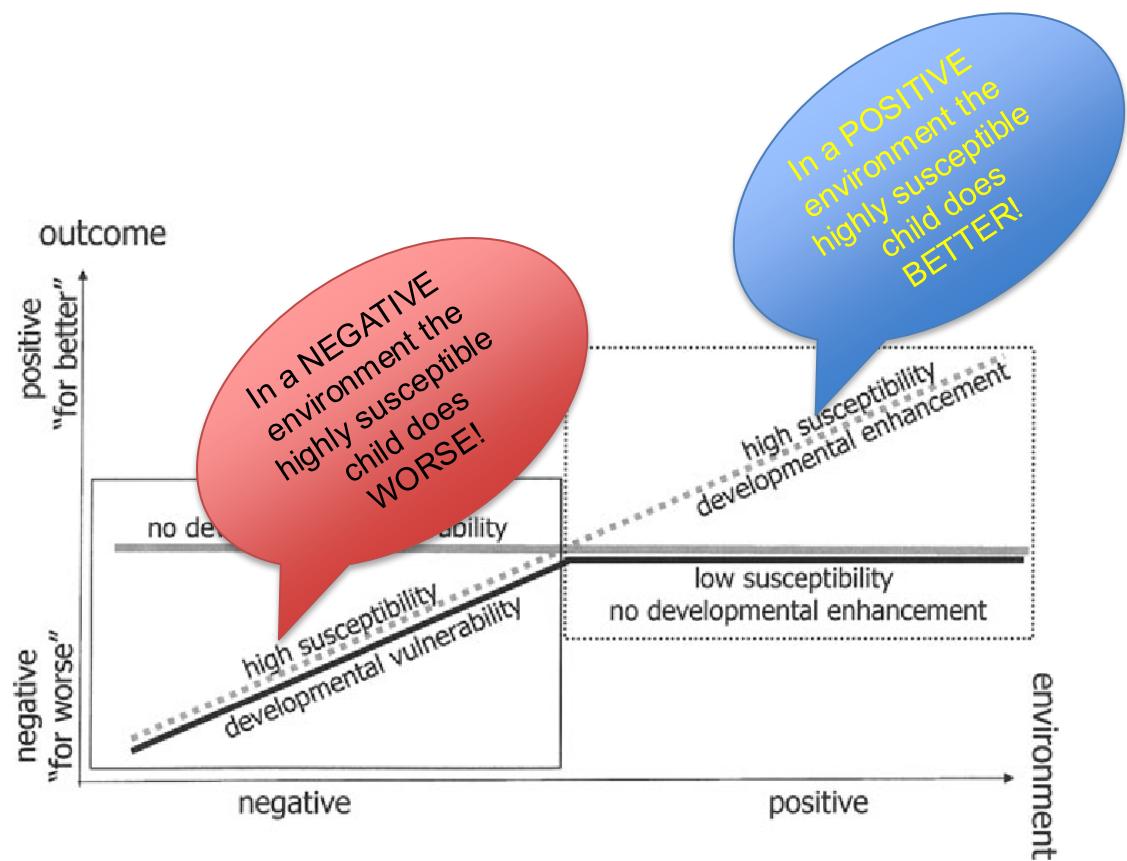


The missing heritability problem

Interactions

This model says that the environment will have a different effect on you depending on how susceptible you are

So, for a highly susceptible child



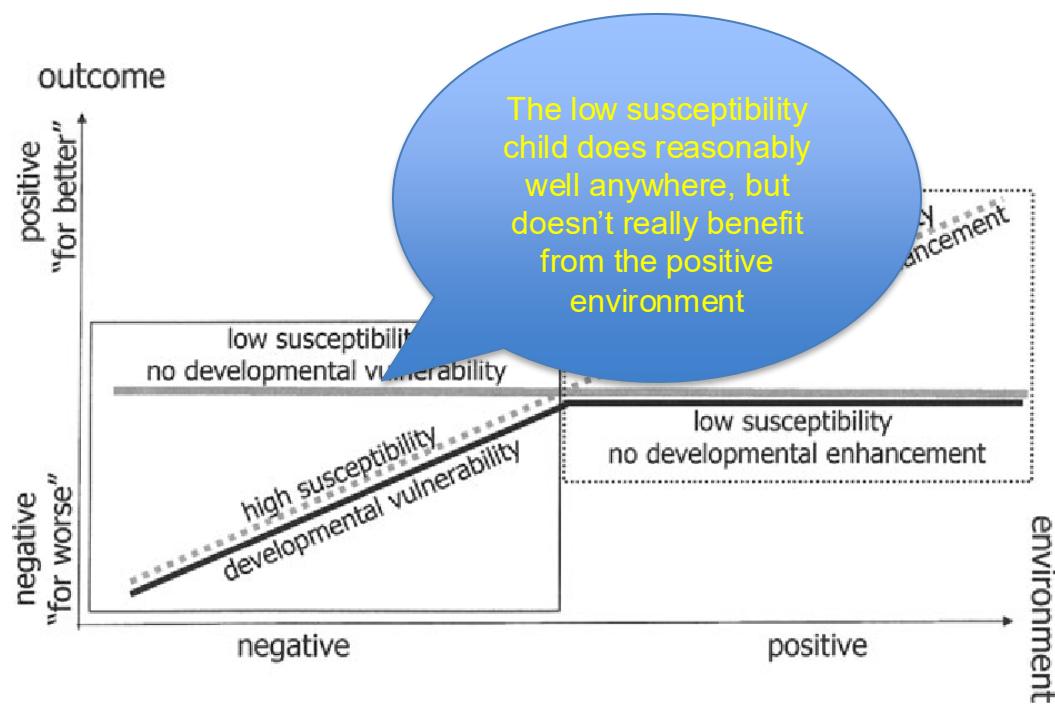
The missing heritability problem

Interactions

This model says that the environment will have a different effect on you depending on how susceptible you are

So, for a low susceptibility child

- ❖ PTC – what would the theory of evolution have to say about differential susceptibility?



The missing heritability problem

Interactions

Differential susceptibility

- E.g. "Can Genetics Predict Response to Complex Behavioral Intervention? Evidence from a Genetic Analysis of the Fast Track Randomized Control Trial, Albert et al. (2015), Journal of Policy Analysis and Management"
- High-risk first-graders
- NR3C1 gene variant (AA, AG, GG)
- Glucocorticoid receptor, involved in social-stress response
- If left untreated, 75 % of high-risk "orchid" children with the NR3C1 gene variant (AA or AG) went on to develop psychological problems by age 25. These maladaptive behaviours include substance abuse, aggression, and antisocial personality disorder
- The good news is that when children with this gene variant participated in an intensive multi-pronged support services through the Fast Track Project only 18 % developed psychopathology as adults.

506 / *Can Genetics Predict Response to Complex Behavioral Interventions?*

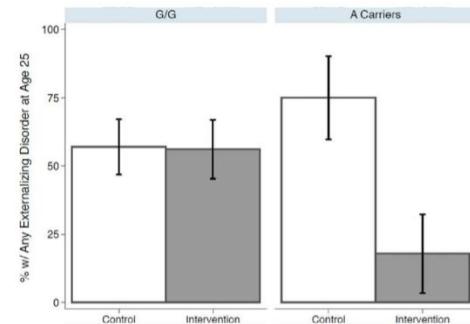


Figure 2. Prevalence of Any Externalizing Psychopathology in European-American Fast Track Intervention and Control Children by Carriage of the rs10482672 "A" Allele.

Notes: The G/G group carried no copies of the "A" allele. The "A" Carrier group carried one or two copies of the "A" allele.

Orchid



The missing heritability problem

- What could the reason be?
3. We are not thinking about it in the right way
- Let's be even smarter...
 - What if we are looking at the right genes but not looking close enough?
 - What if there can be heritable changes to DNA?

Epigenetics...



- Functionally relevant changes to the genome that do not include a change in the nucleotide sequence
- Dynamic alterations in the transcriptional potential of a cell
- One such process = **methylation**

Epigenetics – a bug on a stick

Epigenetics:

- A quick visual review of how DNA works – 2 volunteers required



Epigenetics and the missing heritability problem

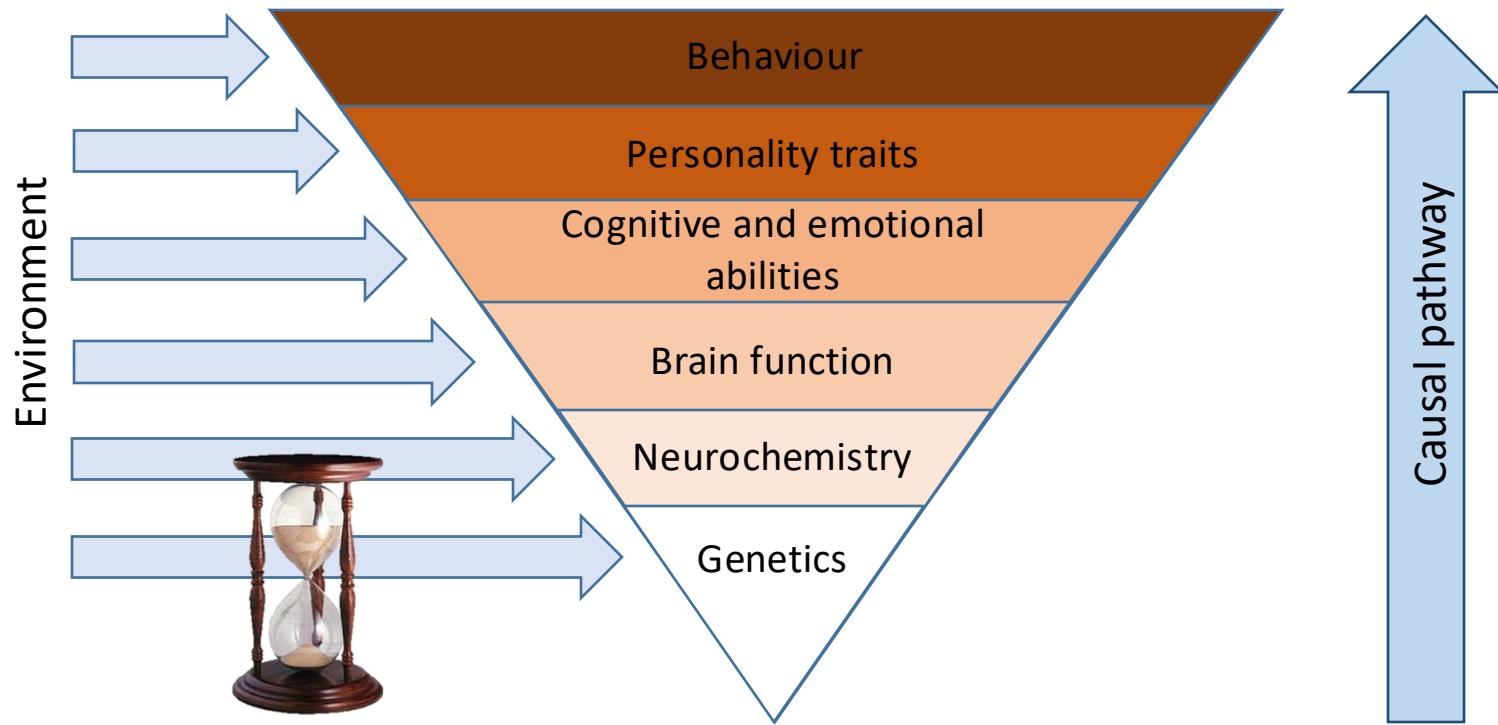
Epigenetics:

- Offers a plausible solution to the missing heritability problem
 - The genotype alone does not dictate gene expression
 - A mechanism for gene-environment interactions
- Provides a challenge
 - Further interactions – genotypic effects on methylation!
 - Further complexities... DNA *structure* and function – 2 more volunteers please!
- Provides hope – epigenetics is a dynamic process
 - It can be slowed down, sped up, prevented, reversed
- Sheds light?
 - Critical periods? Could epigenetic processes be involved?
- Is exciting!
 - This is a relatively new field
 - Based on an understanding of gene **function**
 - Time for a paradigm shift?



Why, as psychologists, do we care?

... because we are scientists!



Extra curricular activity: Sapolsky

Robert Sapolsky – Stanford University (accessible through iTunesU)

<http://www.youtube.com/watch?v=e0WZx7IUOrY>

The whole series is worthwhile...

Make it a date...! Popcorn, beverages, comfy chair... and behavioural genetics