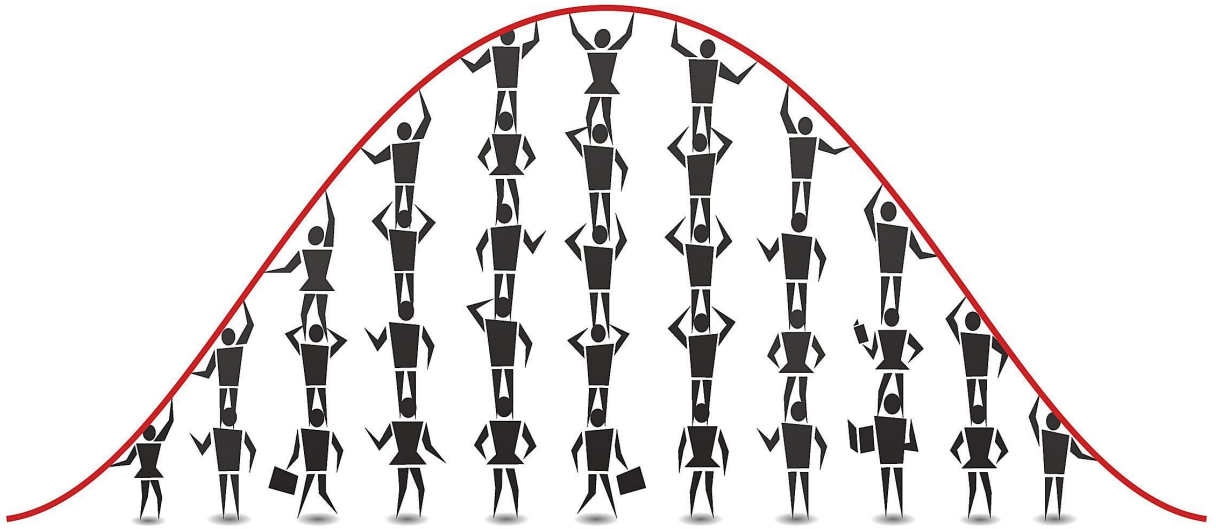
Environmental influence

Genetic influence

Identical twins

Non-identical twins

What is heritability?



- Describes ‘what is’ not ‘what could be’
- Describes normal range of variation
- Genetic *influences* -- *not* innate, immutable, deterministic

How heritable is…

Eye colour

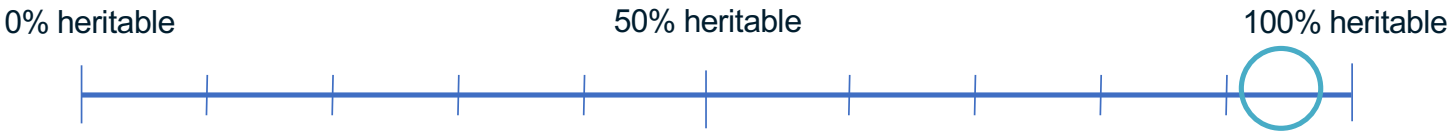
0% heritable

50% heritable

100% heritable

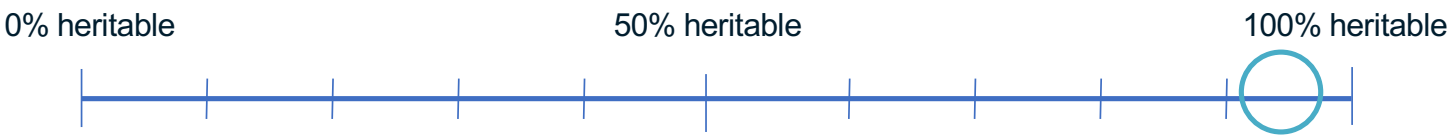
How heritable is…

Eye colour



How heritable is…

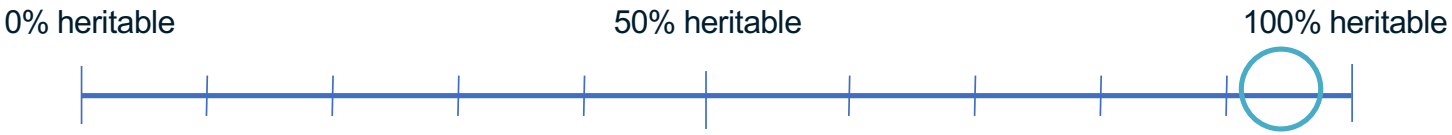
Eye colour



Weight (BMI)

How heritable is…

Eye colour



Weight (BMI)

How heritable is…

Eye colour

0% heritable 50% heritable 100% heritable

Weight (BMI)

0% heritable 100% heritable

School performance

0% heritable 100% heritable

How heritable is…

Eye colour

0% heritable 50% heritable 100% heritable

Weight (BMI)

0% heritable 100% heritable

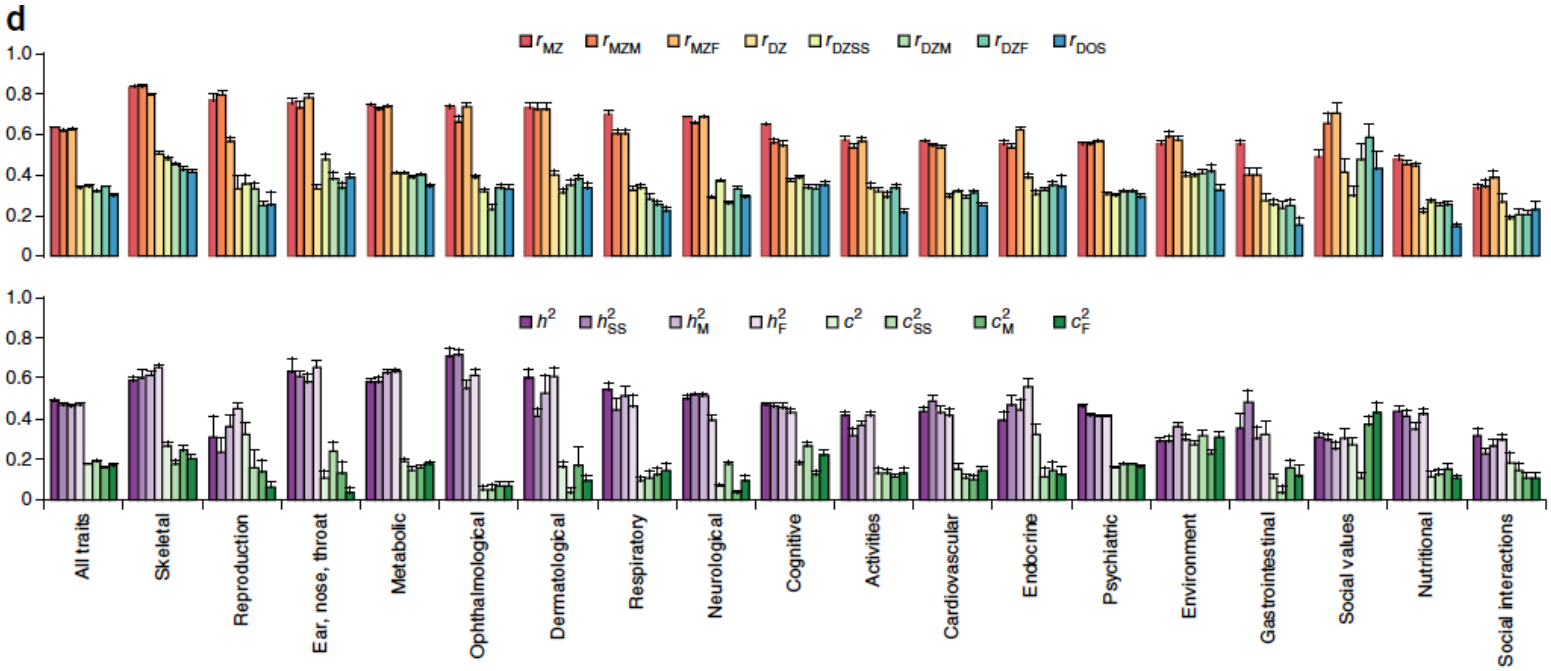
School performance

0% heritable 100% heritable

nature genetics

Meta-analysis of the heritability of human traits based on fifty years of twin studies

Tinca J C Polderman[1,10], Beben Benyamin[2,10], Christiaan A de Leeuw[1,3], Patrick F Sullivan[4–6], Arjen van Bochoven[7], Peter M Visscher[2,8,11] & Danielle Posthuma[1,9,11]



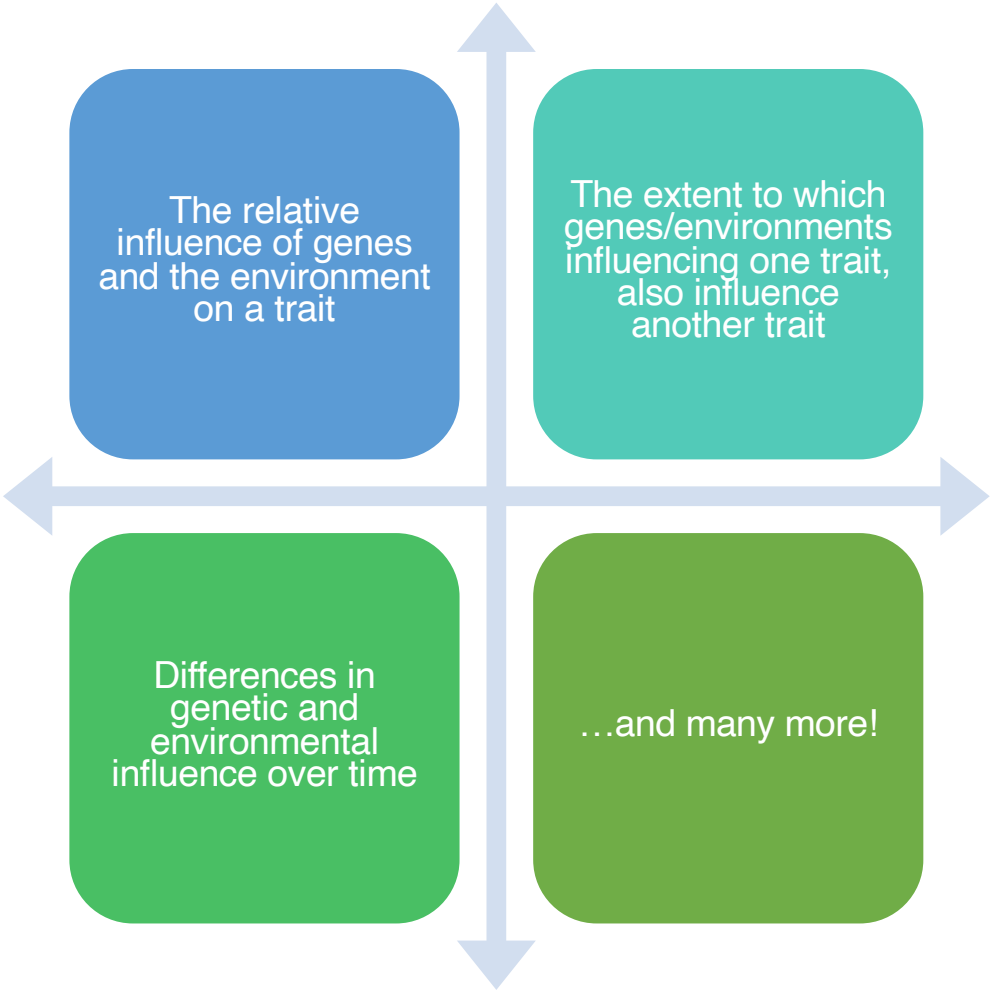
Common misconceptions about heritability

- Heritability does **not** describe an individual
  - It is a population statistic based on the variance that describes populations, not individuals!

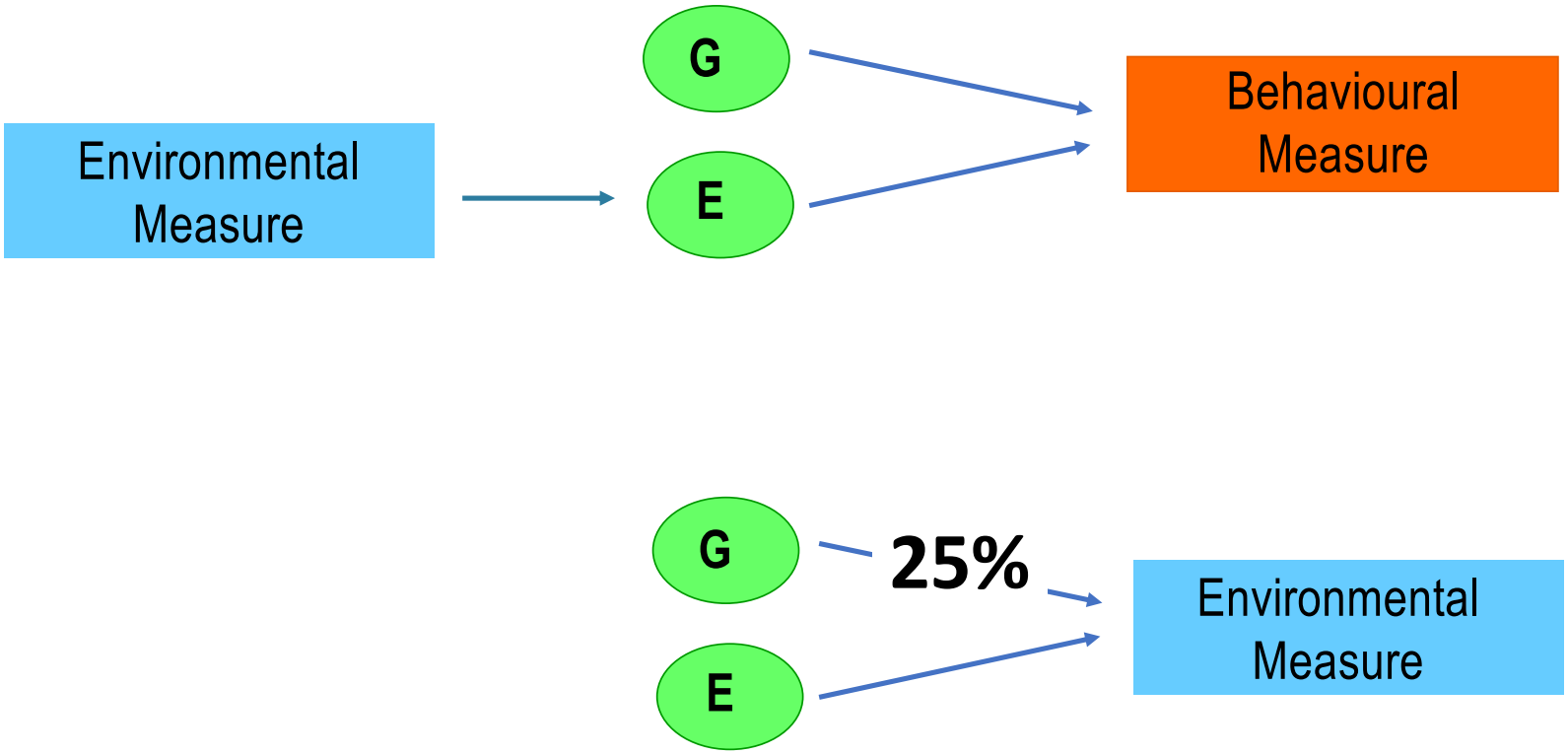
- Heritability is **not** determinism.
  - Just because something is highly heritable **does not** mean it will happen

- Heritability **describes** what **is** in a current population at a current time, **not what could be**
  - BMI is heritable, but you can lose weight!
  - The effects of your genes can change over time, age, and the environment ….

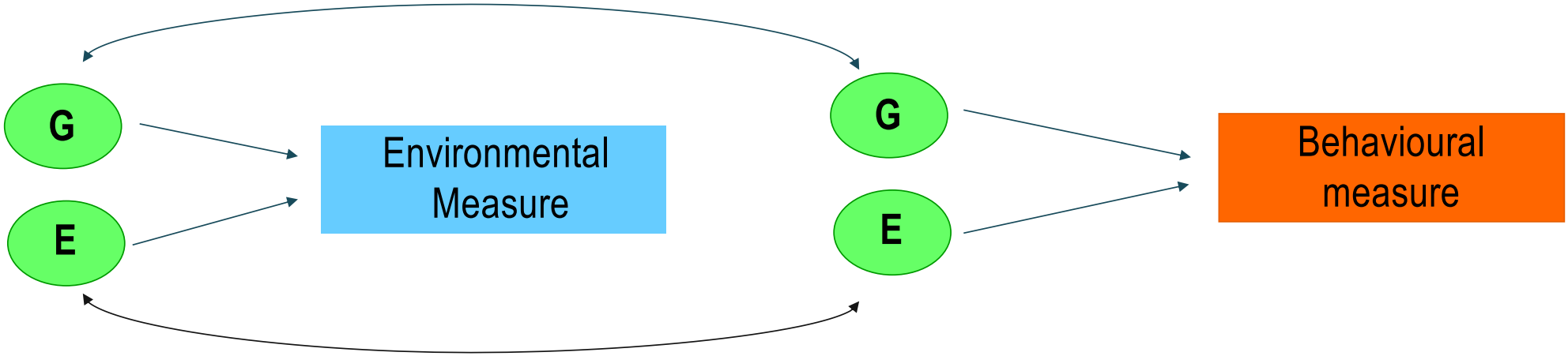
We can use the twin method to ask interesting questions…



What looks like systematic environmental effects are often genetic effects in disguise

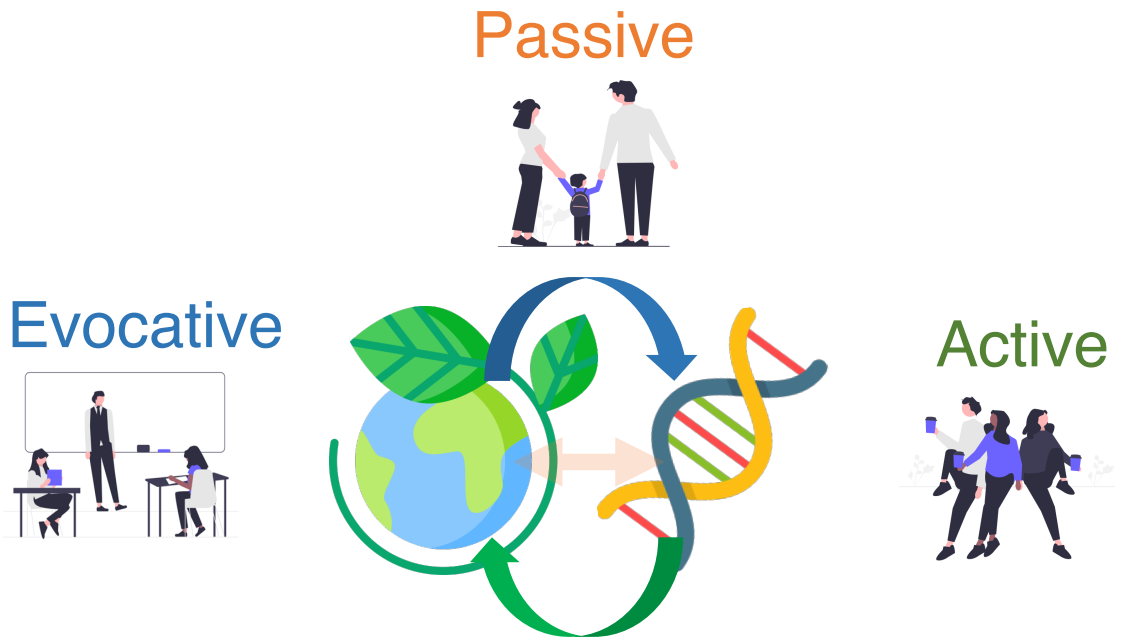


The nature of nurture



The nature of nurture

Transactional models: gene-environment correlation (rGE)



Plomin et al. (1977); Bronfenbrenner & Ceci (1994); Plomin (2014)

Passive model of imposed environments

Active model of shaped environments

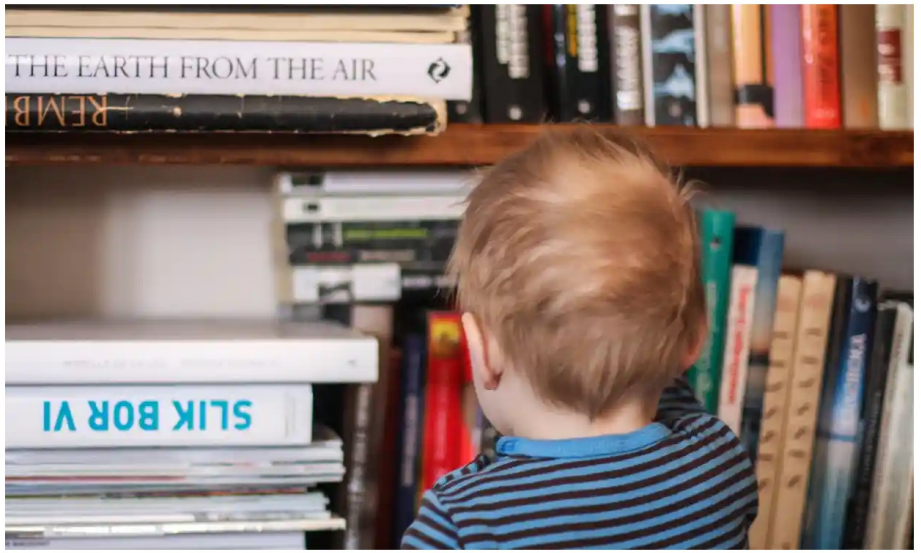
A genetic way of thinking about experience

Growing up in a house full of books is major boost to literacy and numeracy, study finds

Research data from 160,000 adults in 31 countries concludes that a sizeable home library gave teen school leavers skills equivalent to university graduates who didn't read

Alison Flood

Wed 10 Oct 2018 15.31 BST



Ideal home ... a child looks at books on the family shelves. Photograph: Alamy

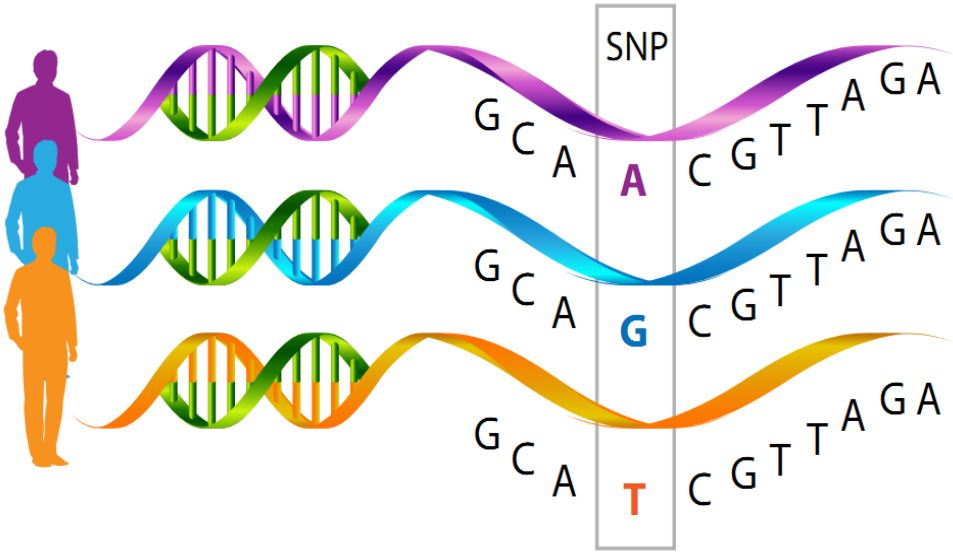
Growing up in a home packed with books has a large effect on literacy in later life - but a home library needs to contain at least 80 books to be effective, according to new research.

Is this information useful in the classroom?

What is a GWAS?

- **<u>GW</u> = Genome-wide**
  - Comprehensive coverage of the genome
  - (millions of **SNPs**)

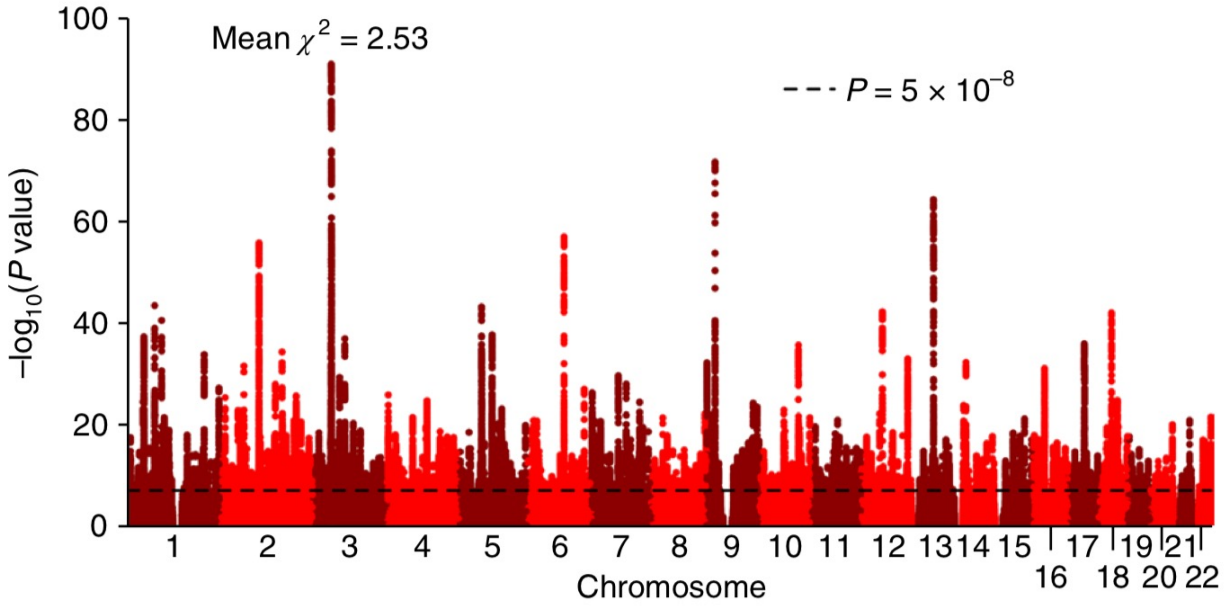
- **<u>AS</u> = Association study**
  - Does a SNP co-occur with a given phenotype?



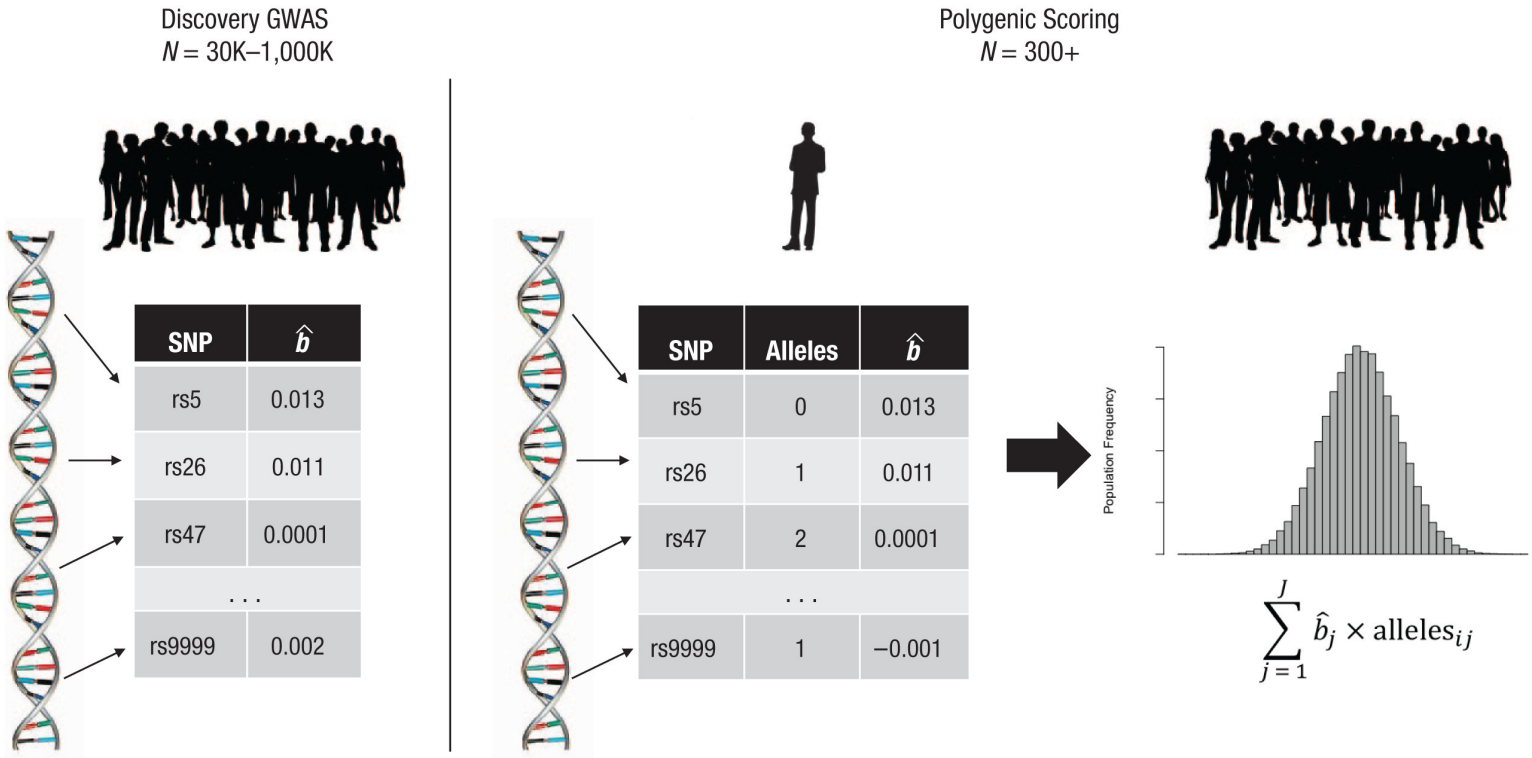
ARTICLES
https://doi.org/10.1038/s41588-018-0147-3
nature genetics

Gene discovery and polygenic prediction from a genome-wide association study of educational attainment in 1.1 million individuals

James J. Lee[1,58], Robbee Wedow[2,3,4,58], Aysu Okbay[5,6,58*], Edward Kong[7], Omeed Maghzian[7], Meghan Zacher[8], Tuan Anh Nguyen-Viet[9], Peter Bowers[7], Julia Sidorenko[10,11], Richard Karlsson Linnér[5,6,12], Mark Alan Fontana[9,13], Tushar Kundu[9], Chanwook Lee[7], Hui Li[7], Ruoxi Li[9], Rebecca Royer[9], Pascal N. Timshel[14,15], Raymond K. Walters[16,17], Emily A. Willoughby[1], Loïc Yengo[10], 23andMe Research Team[18], COGENT (Cognitive Genomics Consortium)[19], Social Science Genetic Association Consortium[18], Maris Alver[11], Yanchun Bao[20], David W. Clark[21], Felix R. Day[22], Nicholas A. Furlotte[23], Peter K. Joshi[21,24], Kathryn E. Kemper[10], Aaron Kleinman[23], Claudia Langenberg[22], Reedik Mägi[11],



Polygenic scores aggregate information from DNA variants into a composite index

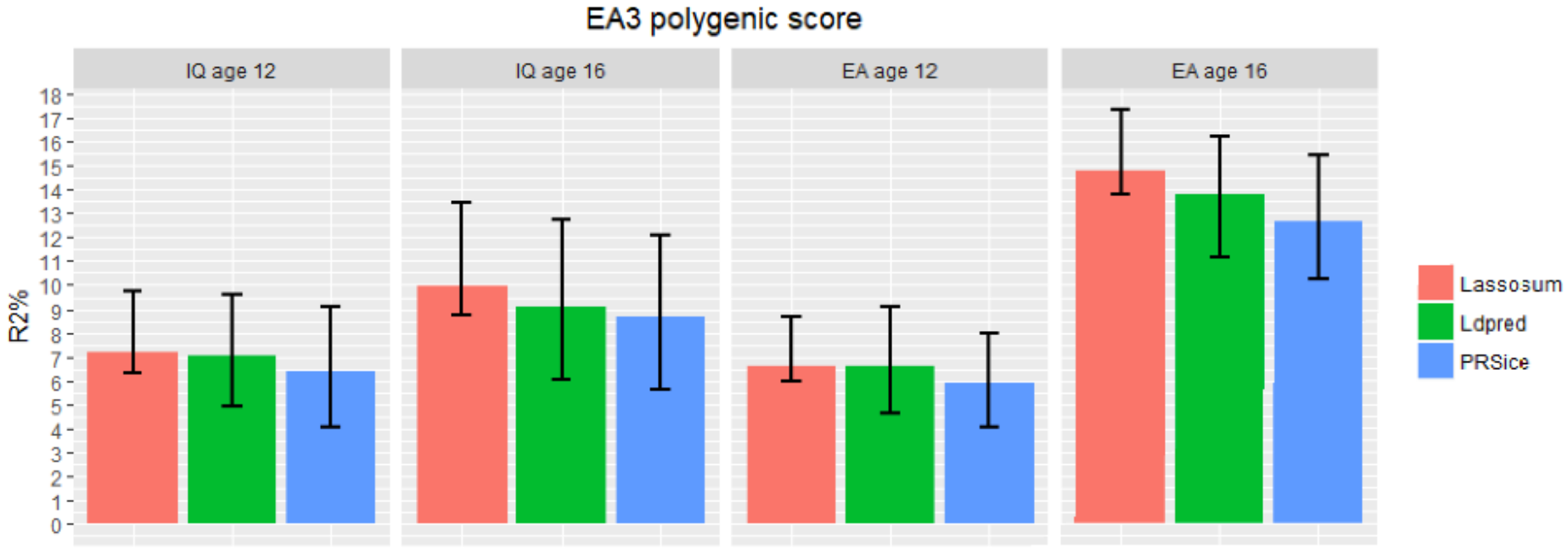


Belsky & Harden (2019), Current Directions Psych Science

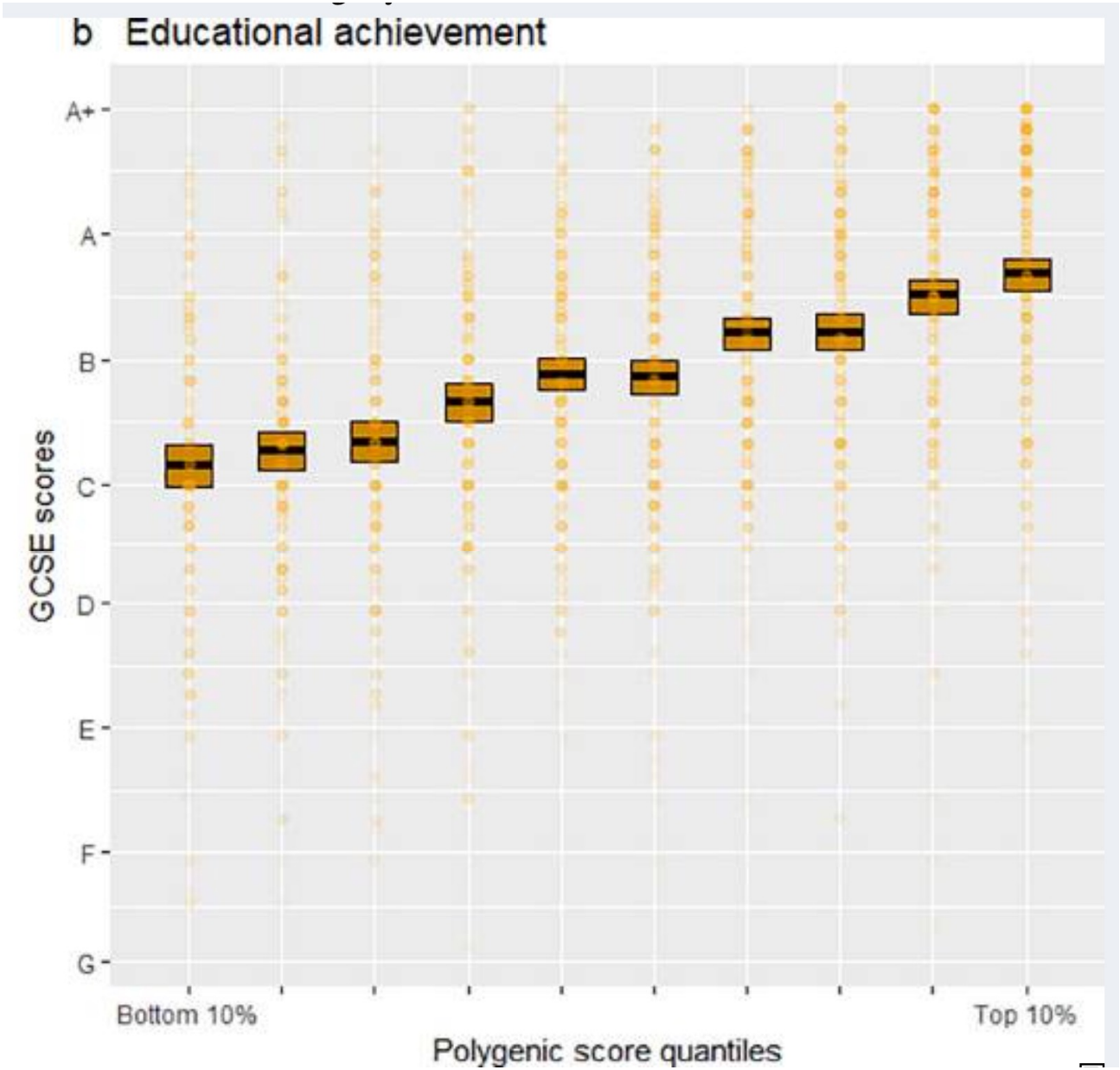
Constructing a polygenic score for one individual

	Increasing allele	Allele 1	Allele 2	Genotypic score	Correlation with trait	Weighted genotypic score
SNP 1	T	C	T	1	.005	.005
SNP 2	C	G	G	0	.004	.000
SNP 3	A	A	A	2	.003	.006
SNP 4	G	C	G	1	.003	.003
SNP 5	G	T	T	0	.003	.000
SNP 6	T	G	T	1	.002	.002
SNP 7	C	C	A	1	.002	.002
SNP 8	G	G	G	2	.002	.004
SNP 9	A	C	C	0	.001	.000
SNP 10	C	C	G	1	.001	.001
Polygenic score				**9**		**.023**

Genomic prediction of cognitive traits in childhood and adolescence?



Allegrini et al 2019
Molecular Psychiatry



Allegrini et al 2019

What can we do with this information in the classroom?