

**THE
GENETIC
LOTTERY**
**WHY DNA
MATTERS
FOR SOCIAL
EQUALITY**
**KATHRYN
PAIGE
HARDEN**

IDENTITY?
FATE?
LUCK?
WORTH?

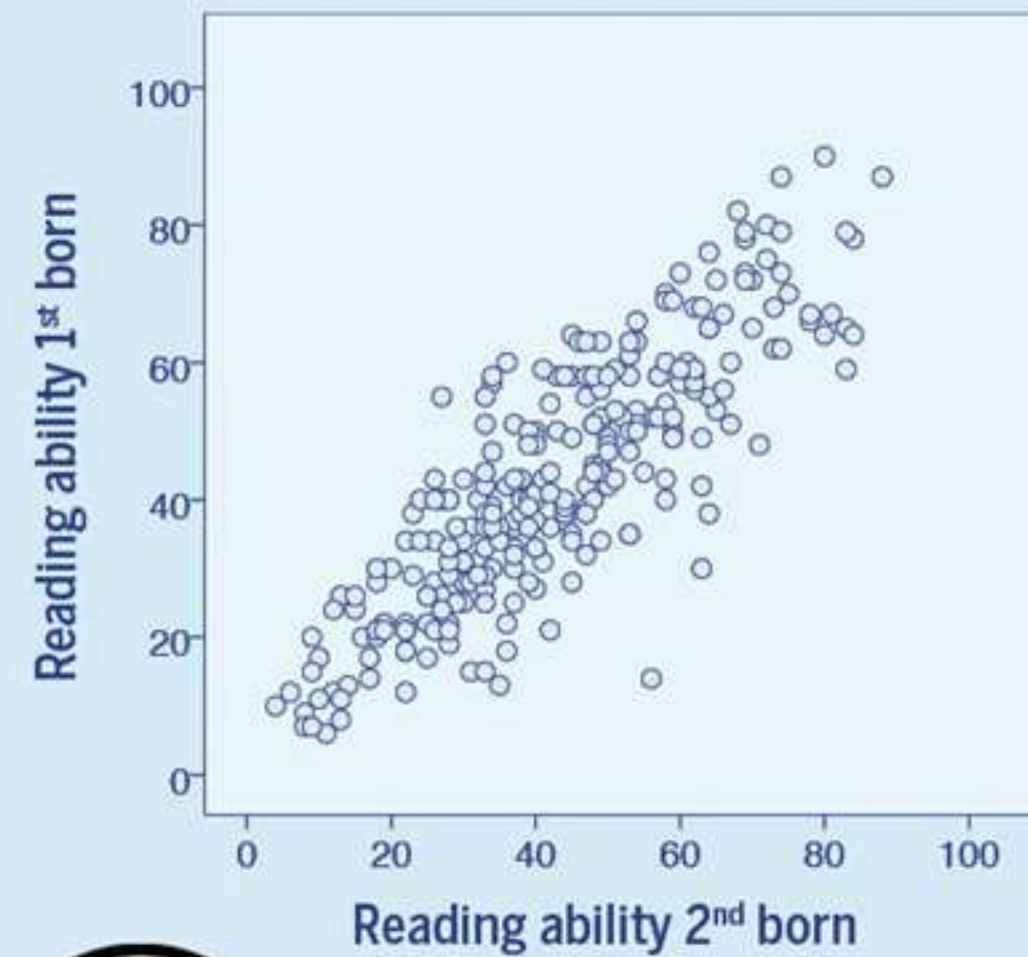
DNA.

I GOT
LOYALTY, GOT ROYALTY INSIDE MY DNA
COCAINE QUARTER PIECE, GOT WAR AND PEACE INSIDE MY DNA
I GOT POWER, POISON, PAIN AND JOY INSIDE MY DNA
I GOT HUSTLE THOUGH, AMBITION, FLOW INSIDE MY DNA

- KENDRICK LAMAR
DAMN.

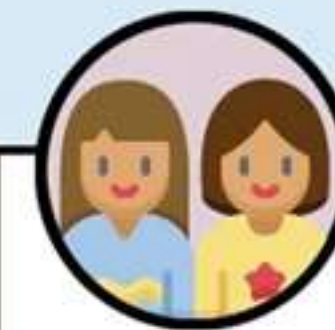
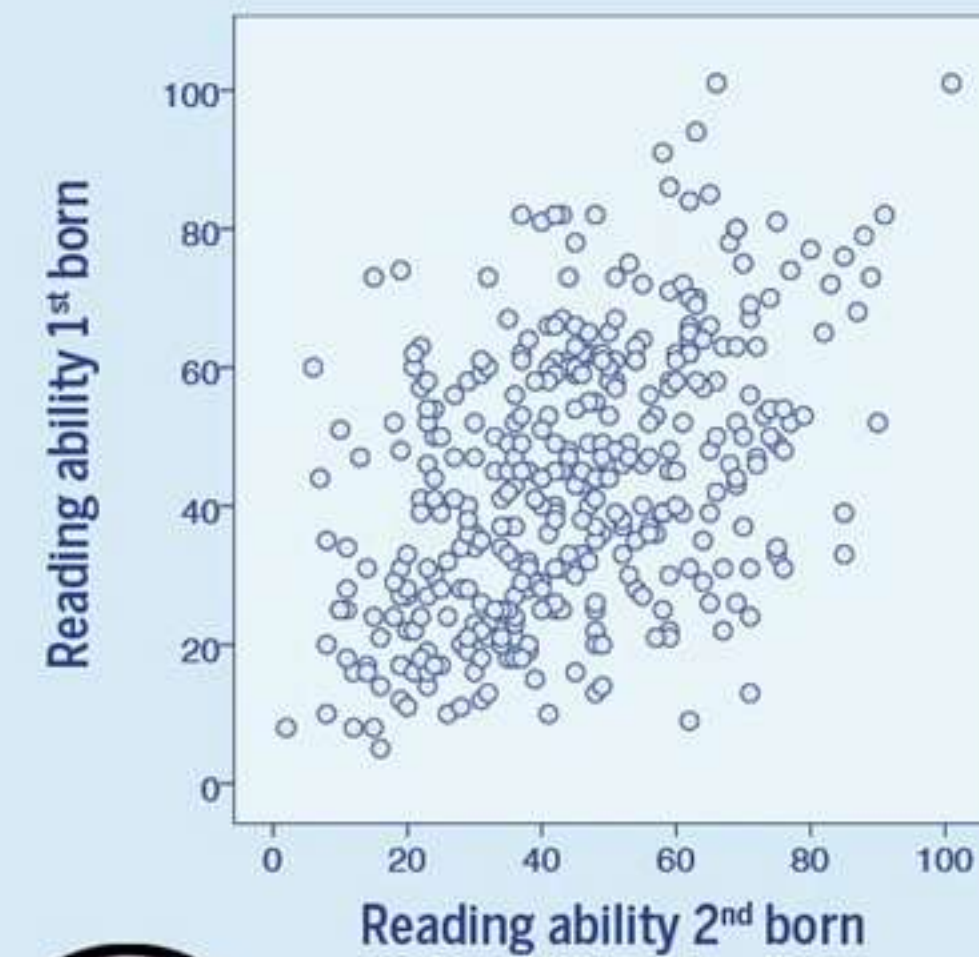


Twin Resemblance



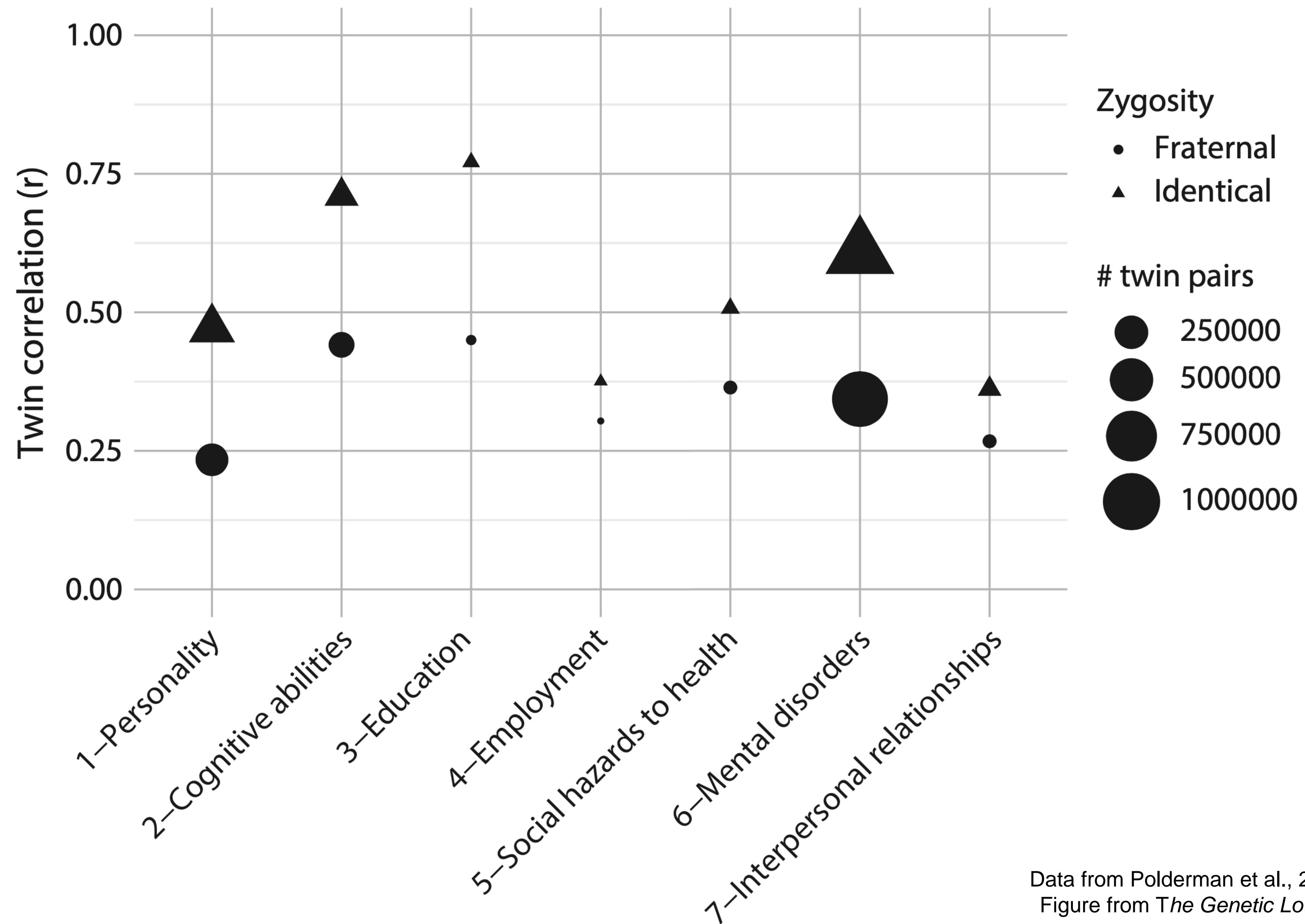
Monozygotic (MZ) Twins

- Share **all** of their genetic influences,
- All of their shared environmental influences, and
- Each child has their own nonshared environmental influences.



Dizygotic (DZ) Twins

- Share **half** of their genetic influences,
- All of their shared environmental influences, and
- Each child has their own nonshared environmental influences.



Data from Polderman et al., 2015, *Nature Genetics*.
Figure from *The Genetic Lottery* (Princeton, 2021)

GGTC**T**TTTTATTTTATTTTGTAGAGTAGTGACATGATGTGACATATTTTACAGGGTCA
TCAGATGGTAATAATAAAGGTGATGAAAATTGGTTAA**A**TTCTGGATATATTCTGAG
AATGTGCAACTAGGTT**G**AACTATAT**G**AAGACAACCTTTTTTTGATCTACAAAACAAAA
TGACGTGTAGGGTGTCTGCA**G**TGGCGCTATGGAGTAGGGCAGATAGAGGTGAATCT
TATGAGAGCA**G**AAGAGAGAACTAGCCAAT**G**ATGAAAGAGGGTTAA**G**AGGAATA**C**GA
TTCCACACCATTTTTGCCTGG**C**TTATCTCCTCCCCCAGACCTTC**A**GGCCTGTGCTTCA
TTTTTTT**G**GAGAAAGTCCAGGTGAGAACATATTACAGCC**T**TGCACTCAAG**G**TGTAG
ATTTATATACACAT**T**AAGGTTTGC**C**CTCAAACCTATATTTAGTTCTTTTATGGATAT**G**
ATTTAAAAAAAACAAAA**A**CAACTACATGAAGAGGGCTTTTGAAGAA**A**ATCTTATGT
TTTAAATTTTGGCTGTTTAAATATGACATACCATG**C**ATAATGACTGATACAATCTTCC
ATAAA**T**ACCCTGCAGGGCAGACGGCTACCACTCTTAAATCTCCTATTTTCTATTT**G**GA
GA**G**GGTACTAAAATATTGTTTGTCTTAAACCCCAAAGCATGCCCCACCTTGTGGTTTA
GGATTGCCATC**C**CTCCTTTTTGTGC**A**CATTATAACTCCT**A**TCTCTGAATTTAGA
CACCTCTGGATTTACATAGTTTTTATCTTTCCCCCTTAATTAAGTTAAAGTCCTAGAT
TCTGTTTGTCTTTTAAAAATGGGGATAATTAAGCATACCCTGTGTTCTCTACGT**G**GCTG
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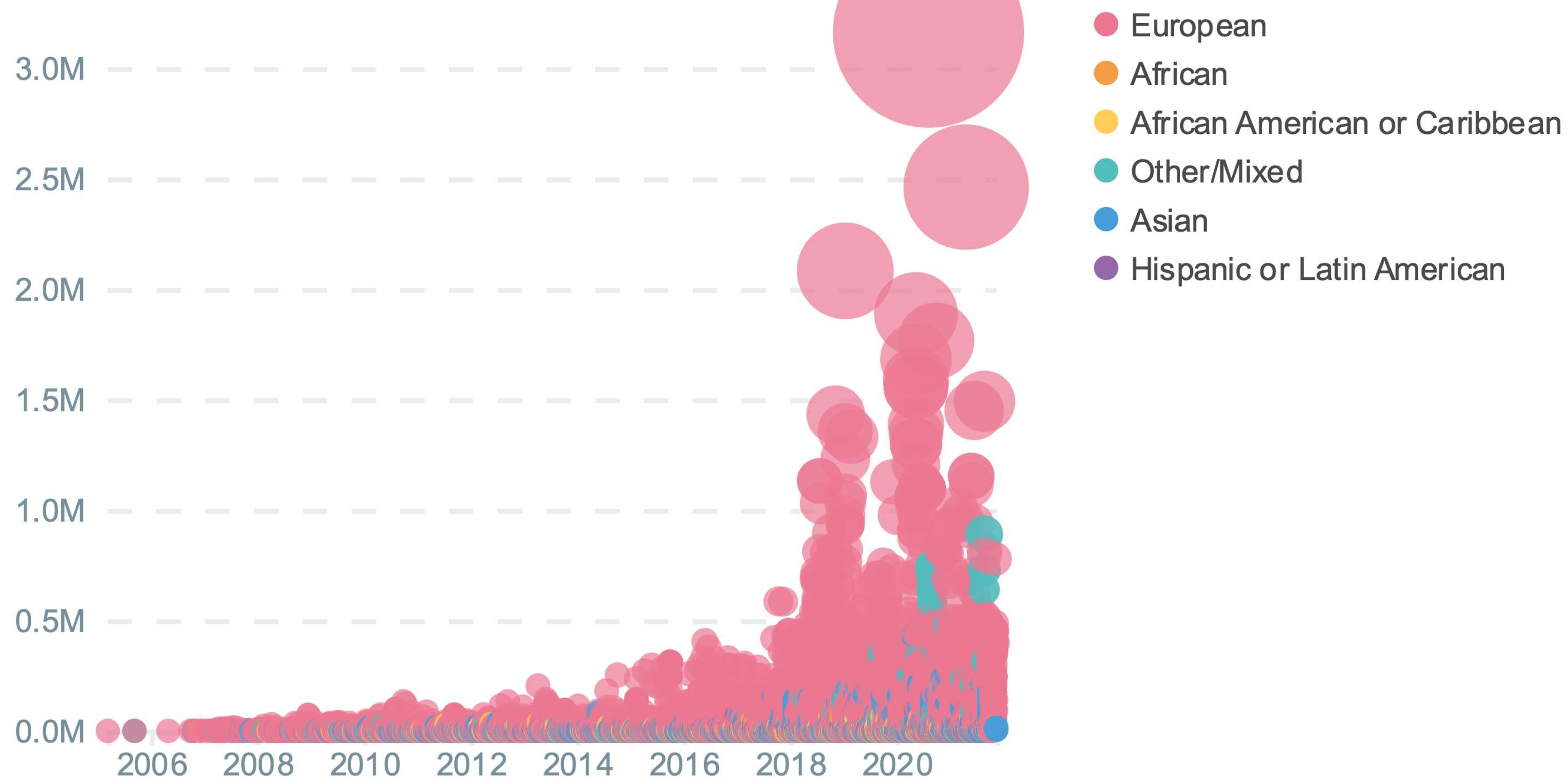


GWAS

Diversity Monitor

Ancestry over time by parent term

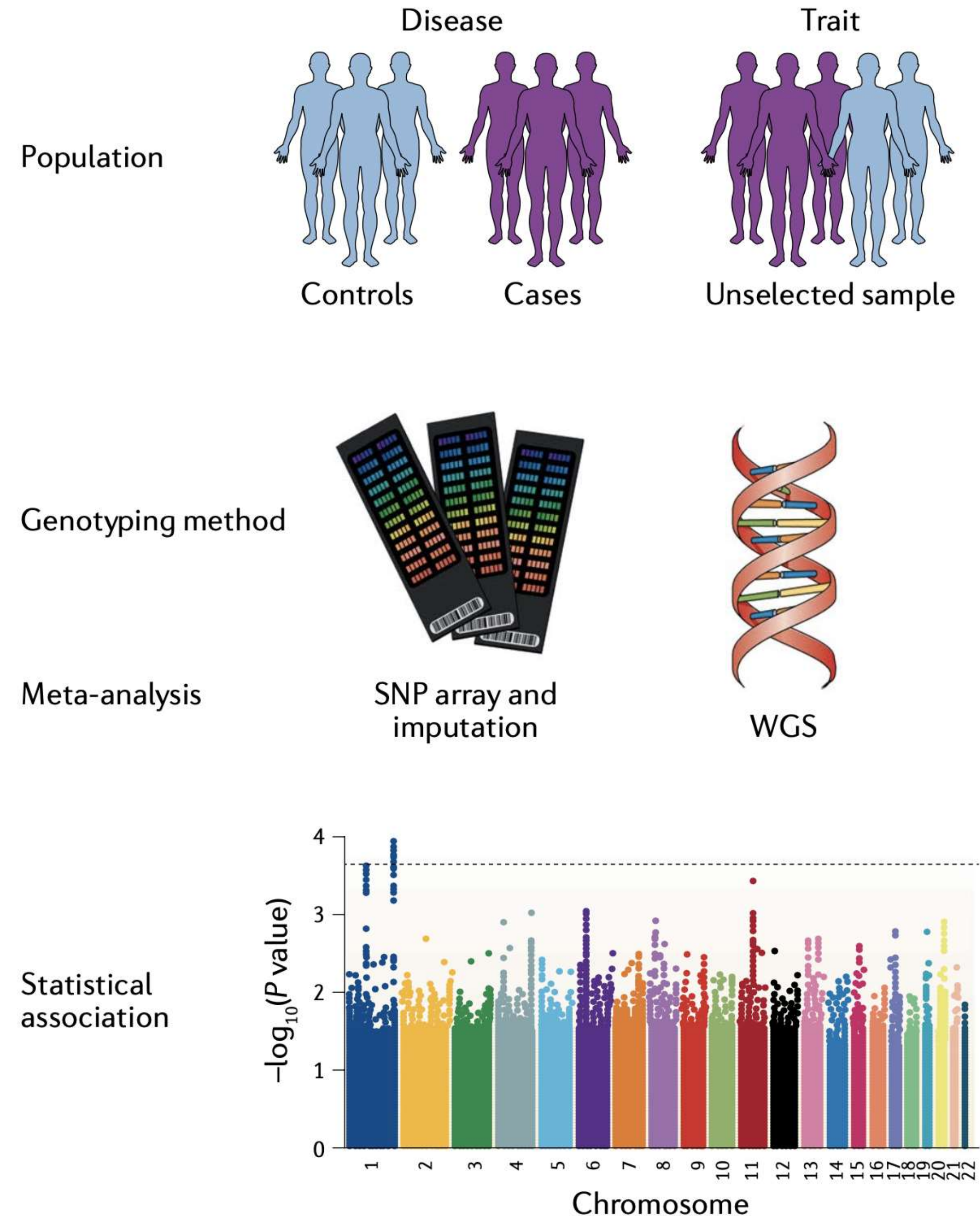
Discovery Stage - All parent terms



GENOME-WIDE ASSOCIATION STUDIES

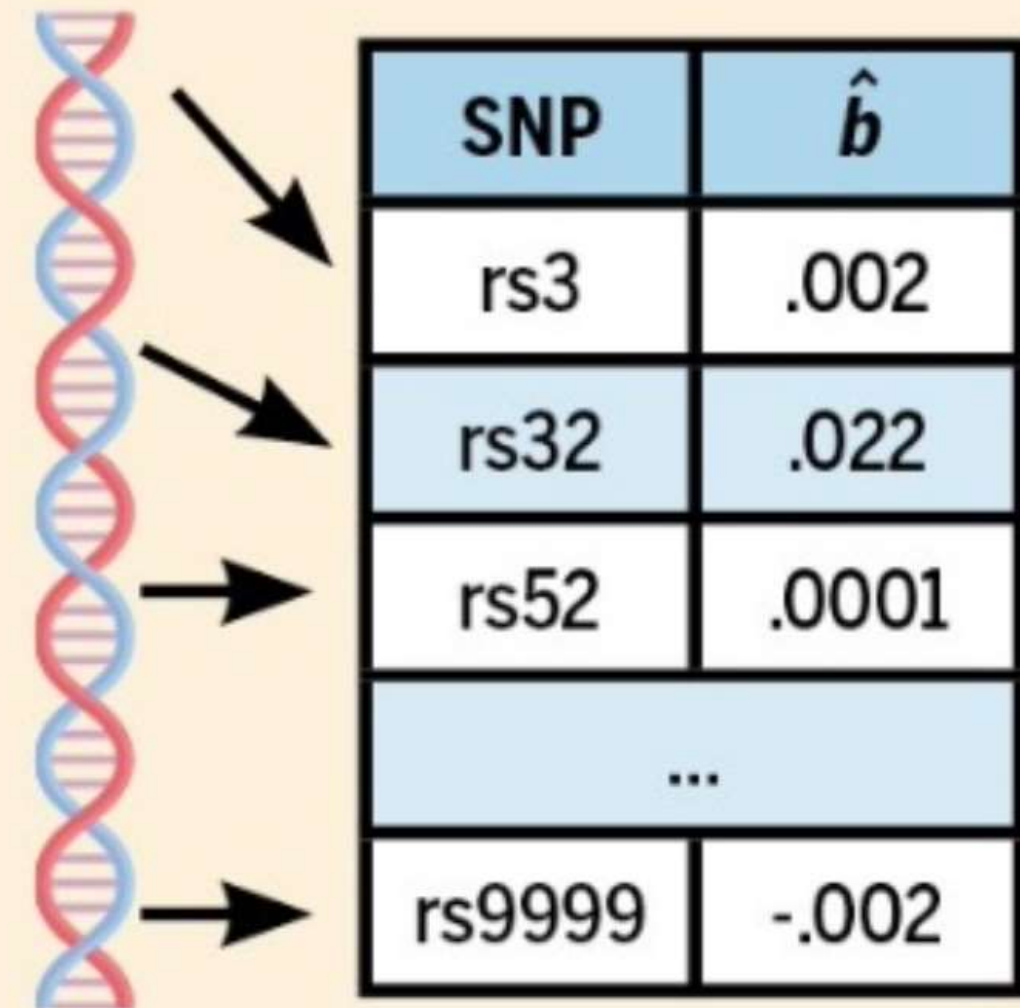
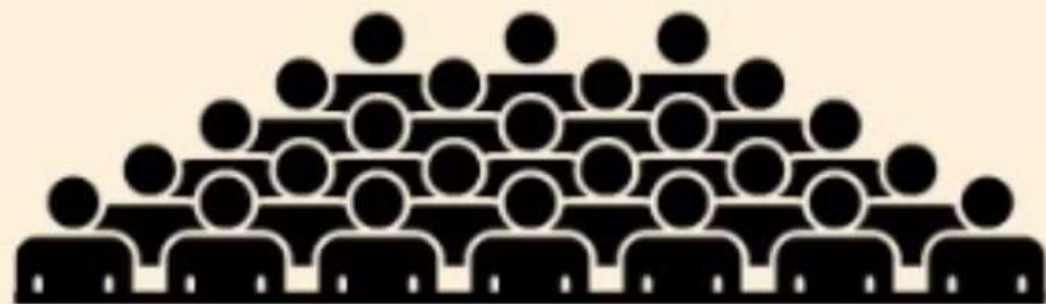
- Measure DNA *variants* that differ between people....
- In very, very, very many people...
- Who are all similar in their genetic background ...
- But who differ in some *phenotype* ...
- To find *genotypes* that are *correlated* with the phenotype

a Genome-wide association



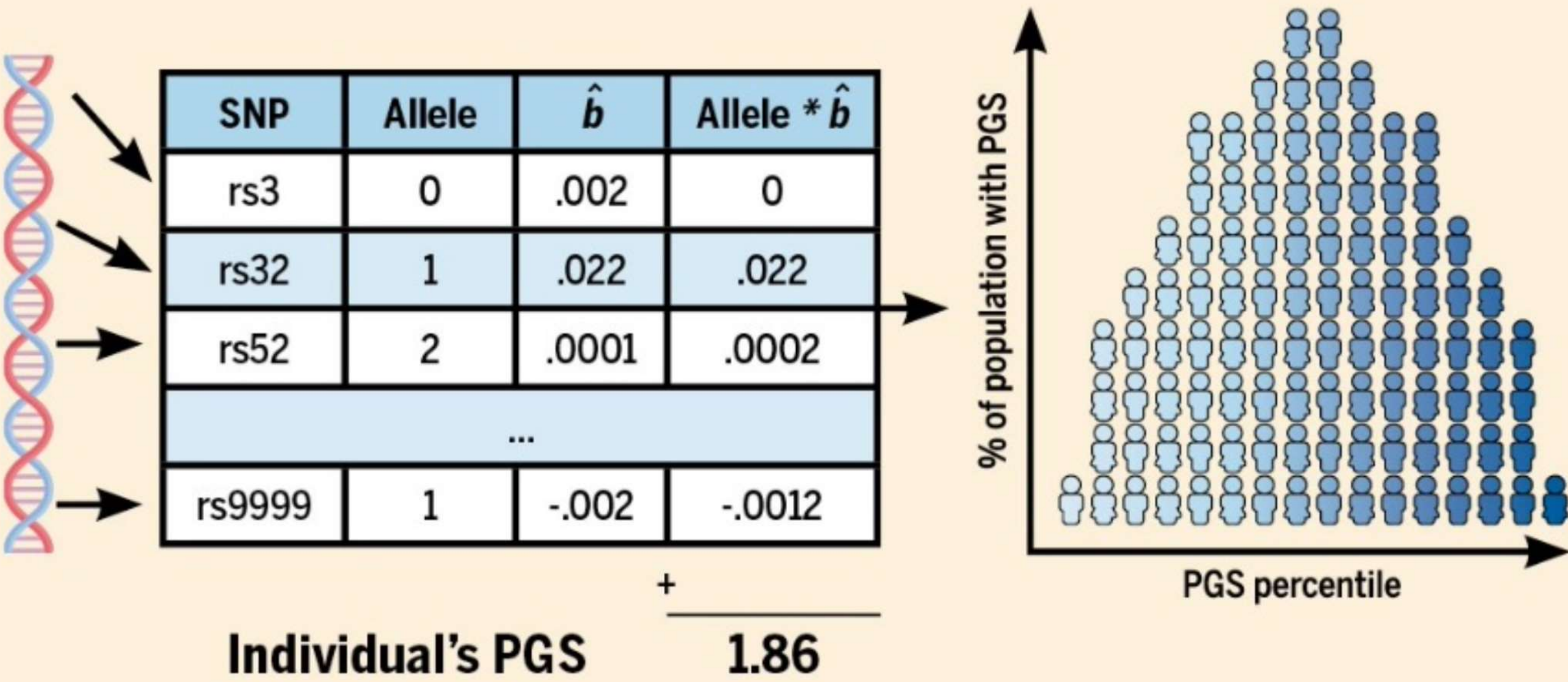
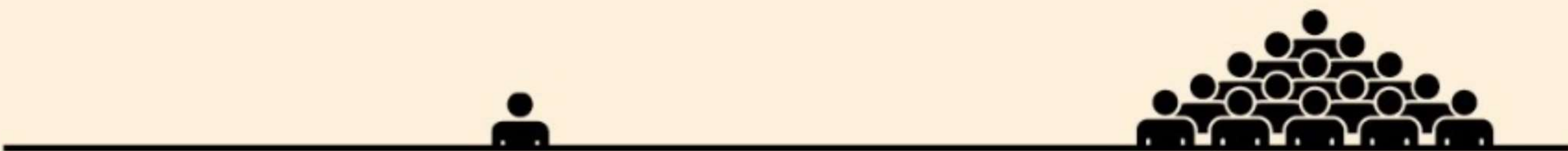
Discovery GWAS

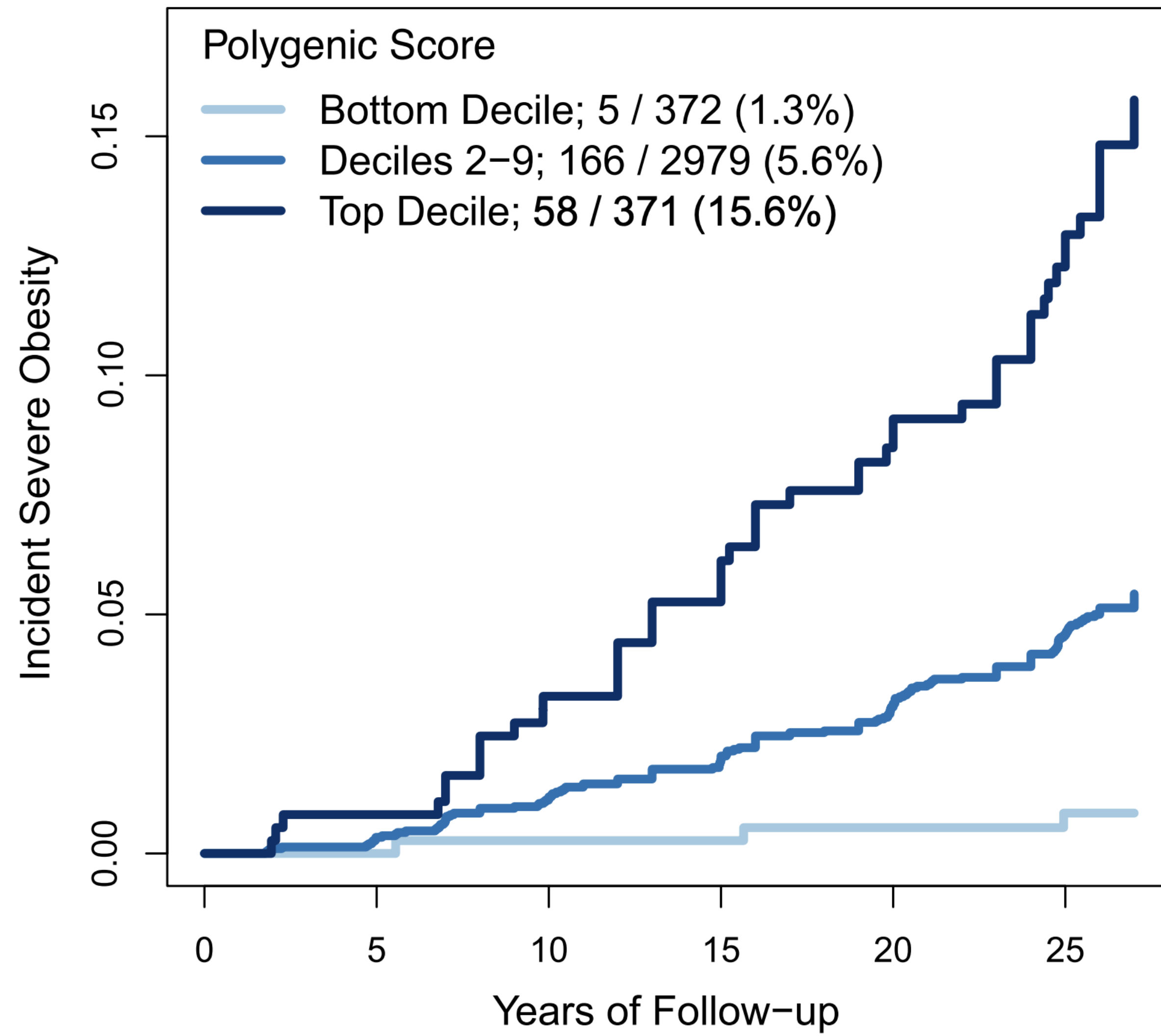
$N = 30K-1,000K$



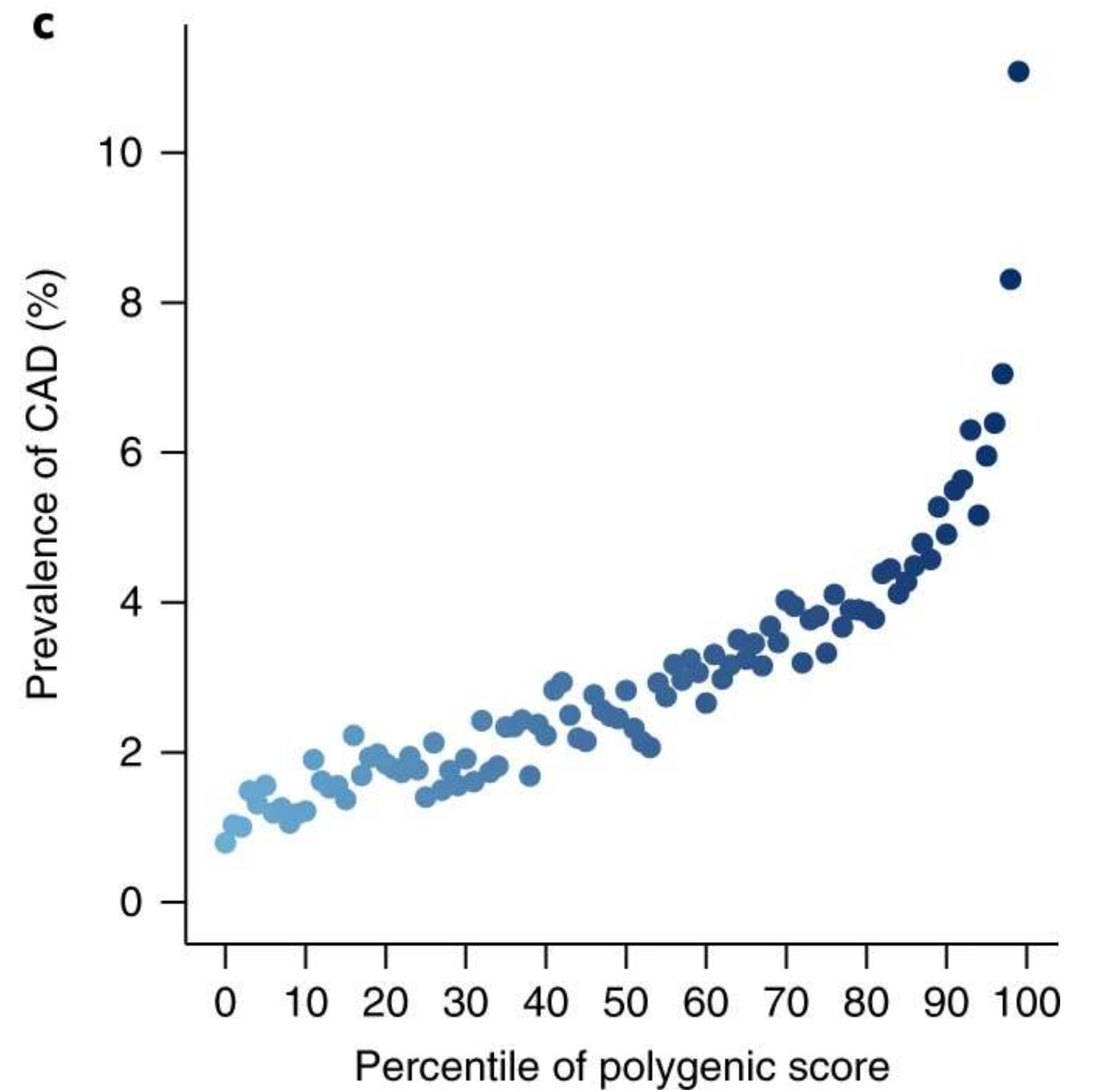
Polygenic Scoring

$N = 300+$



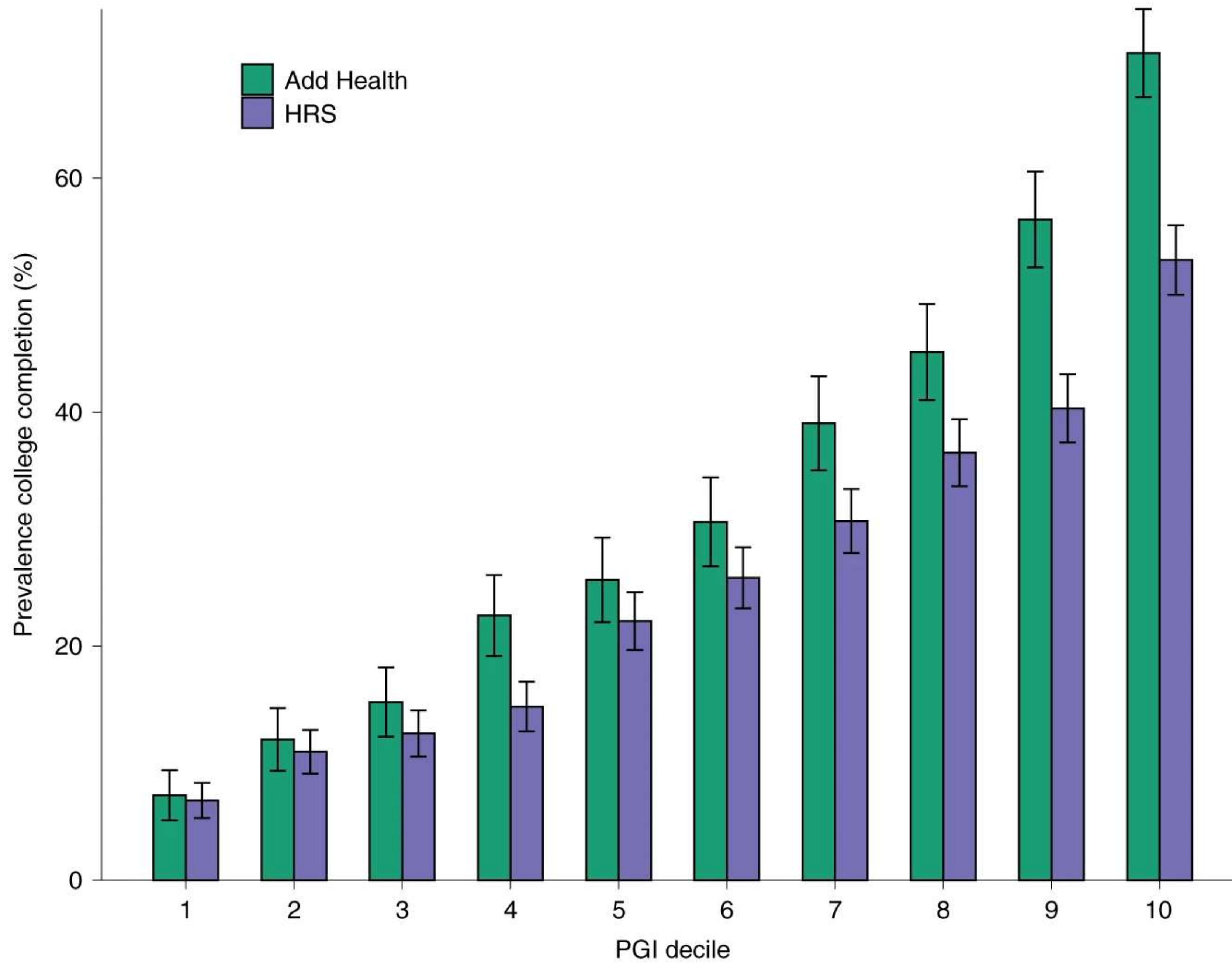


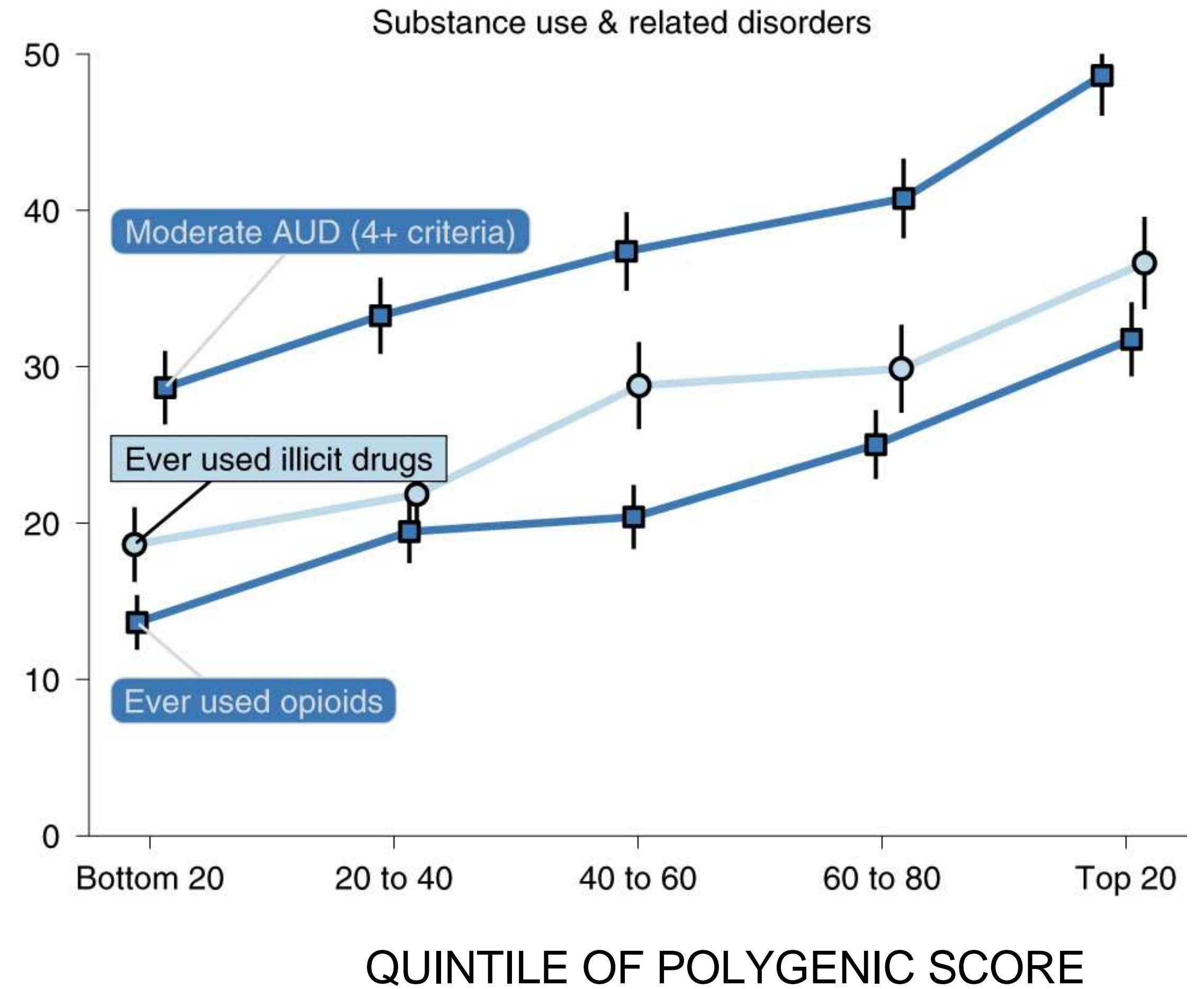
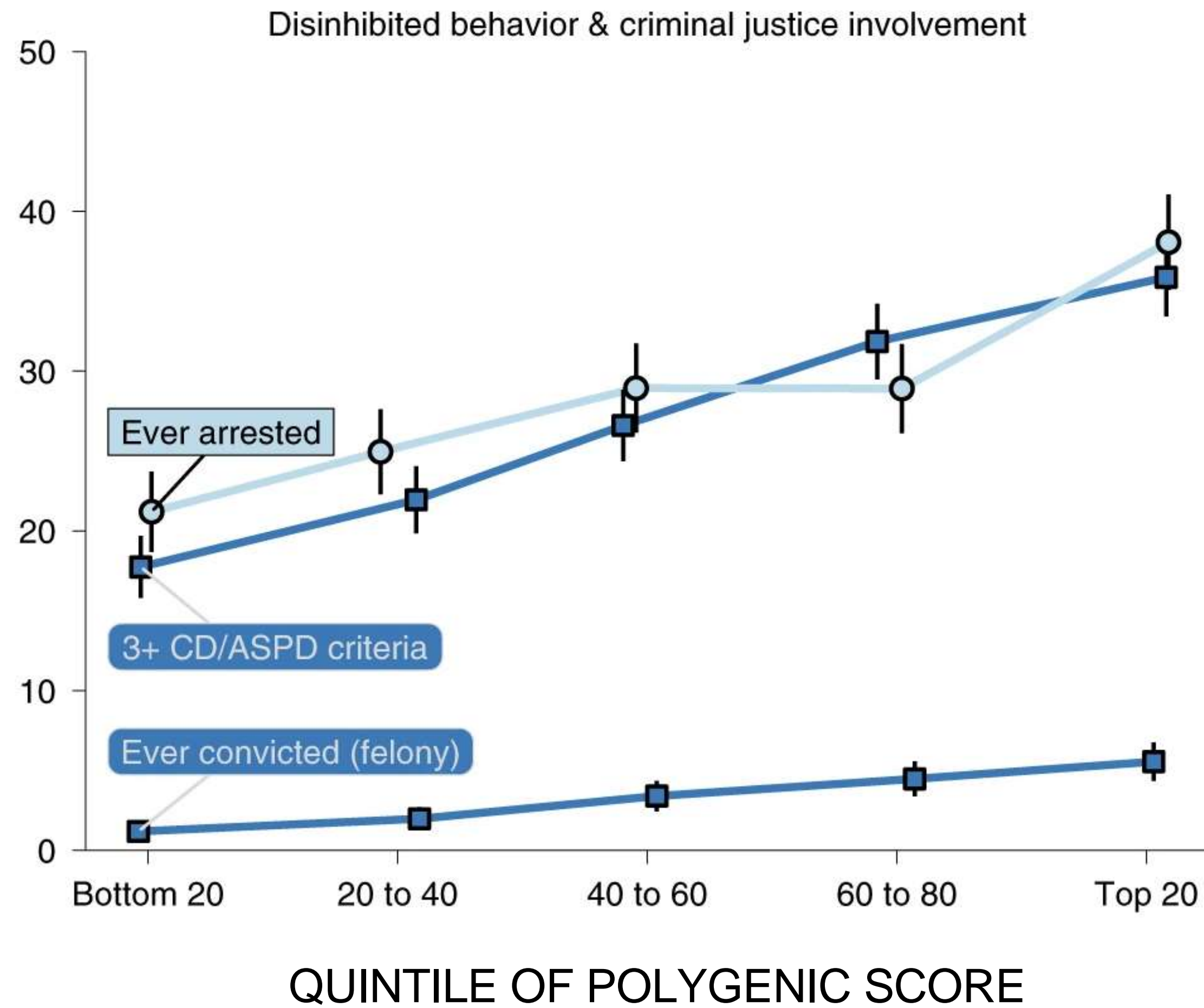
Khera et al. (2019) Cell



Khera et al. (2018) Nature Genetics

b





FATE

IS DNA YOUR DESTINY?

BIOTECHNOLOGY

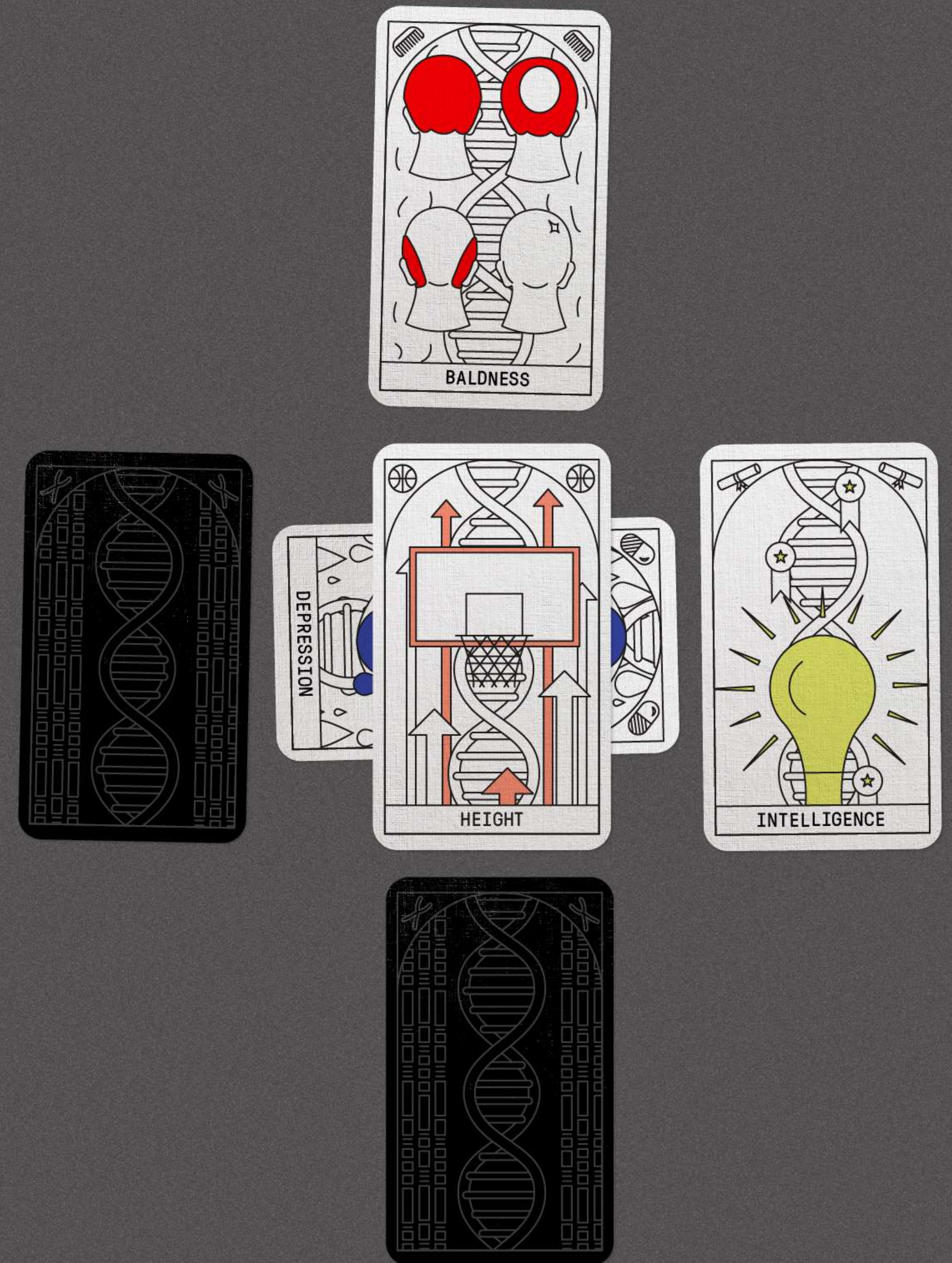
Forecasts of genetic fate just got a lot more accurate

DNA-based polygenic scores are getting better at predicting intelligence, risks for common diseases, and more.

By Antonio Regalado

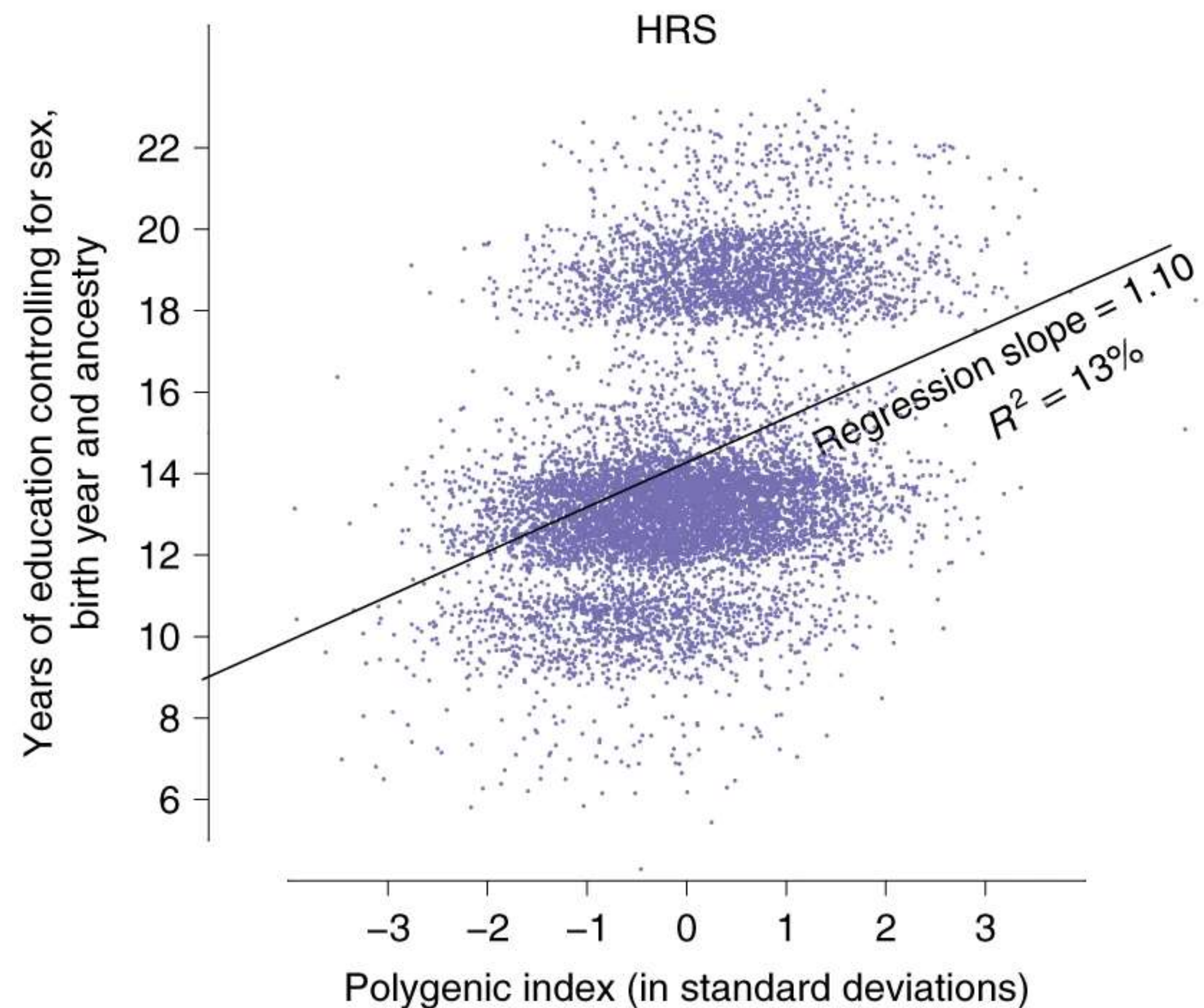
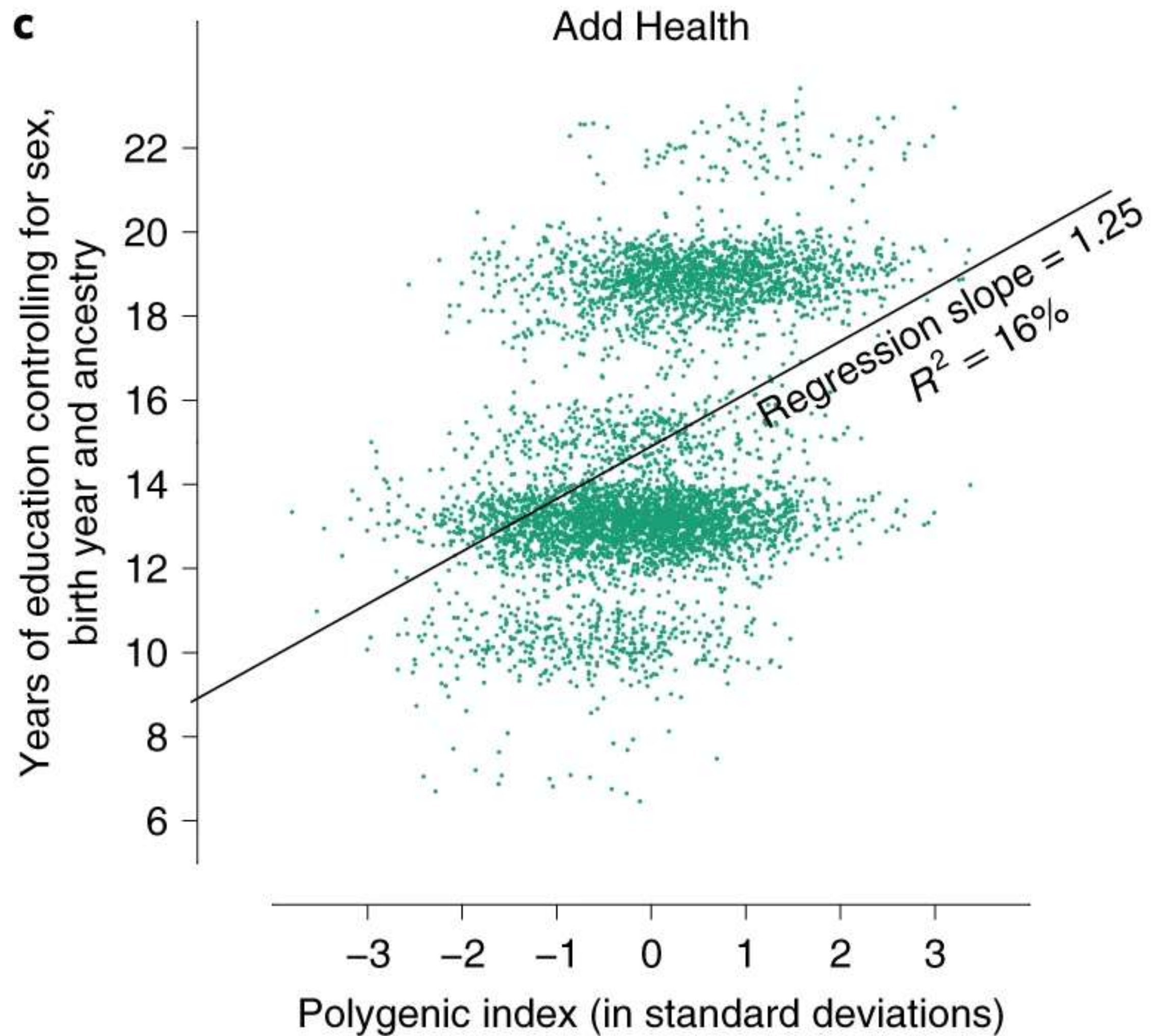
February 21, 2018

Here's the breakthrough: a new way to guess your chance of serious disease from your DNA. Any drawbacks? You bet. The technology could lead to a society where people get genetic grades at birth.



“A devil, a born devil, on whose nature
Nurture can never stick; on whom my pains
Humanely taken, all, all lost, quite lost ...”

WILLIAM SHAKESPEARE, *THE TEMPEST*



NURTURE CHANGES THE EFFECT OF NATURE

Intervention

- Therapy
- Policy
- Economic and political context



IDENTITY

IS YOUR DNA THE “REAL” YOU?

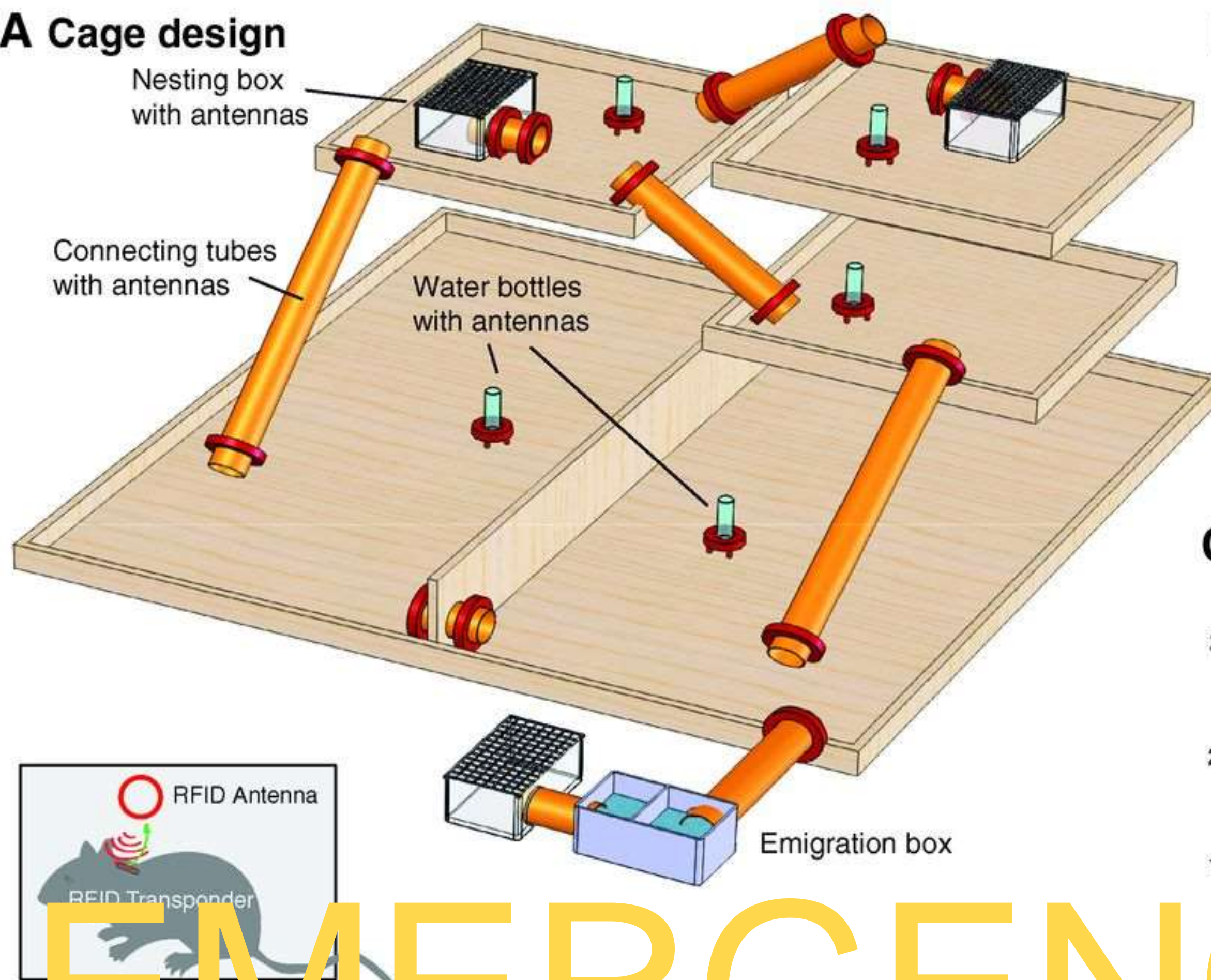


The belief that all objects have a substance that make it what it *is*; without that substance it would not be *that* kind of thing.

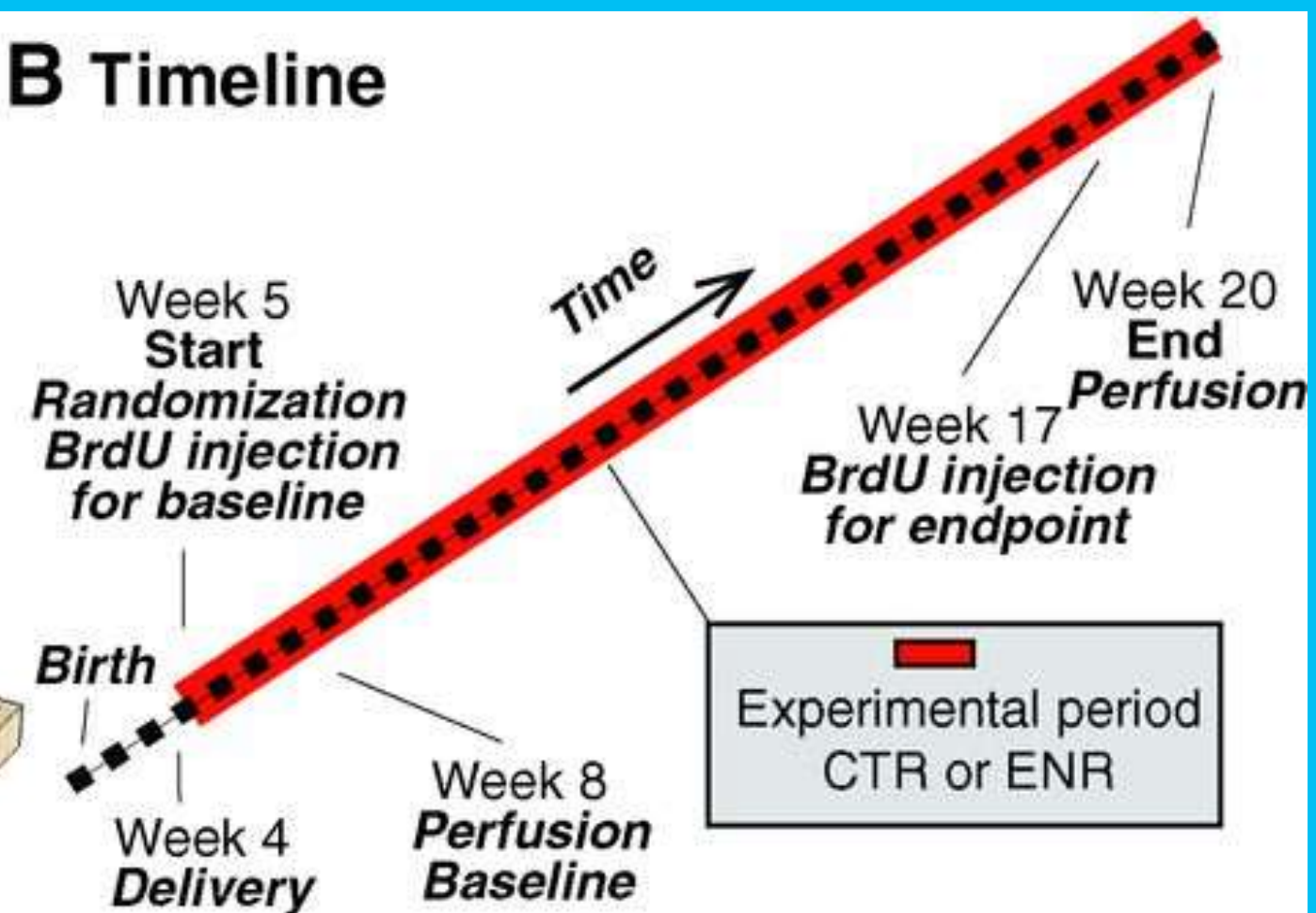
GENETIC ESSENTIALISM



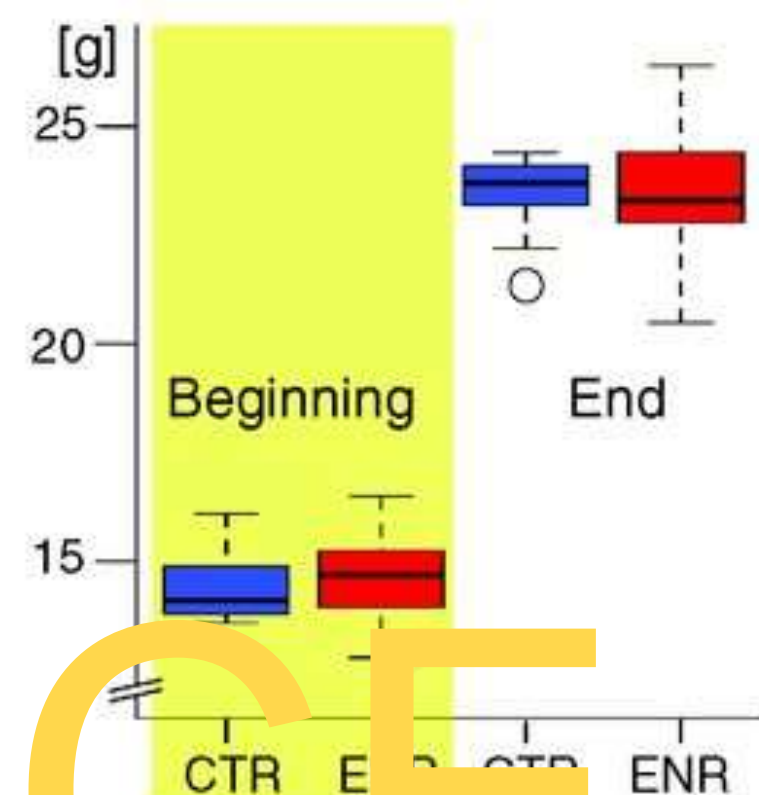
A Cage design



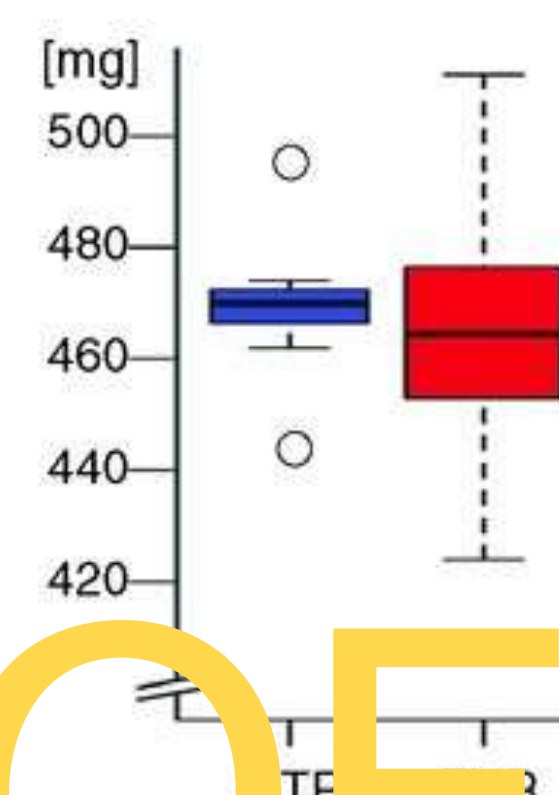
B Timeline



C Body weight



D Brain weight



EMERGENCE OF INDIVIDUALITY

Over time, genetically identical mice diverge in their behavior and brains.

(Freund *et al* 2013)



Stefan Ruiz for The New York Times

“Maybe if he had grown up in Santander, he would have joined the guerrillas, who were popular a decade earlier but also brutal. Far from believing in the inevitability of his professional success, he worried about whether his character, in that alternate life, would have withstood the forces around him....”

SUSAN DOMINUS, “THE MIXED-UP BROTHERS OF BOGOTA”, *NEW YORK TIMES MAGAZINE*

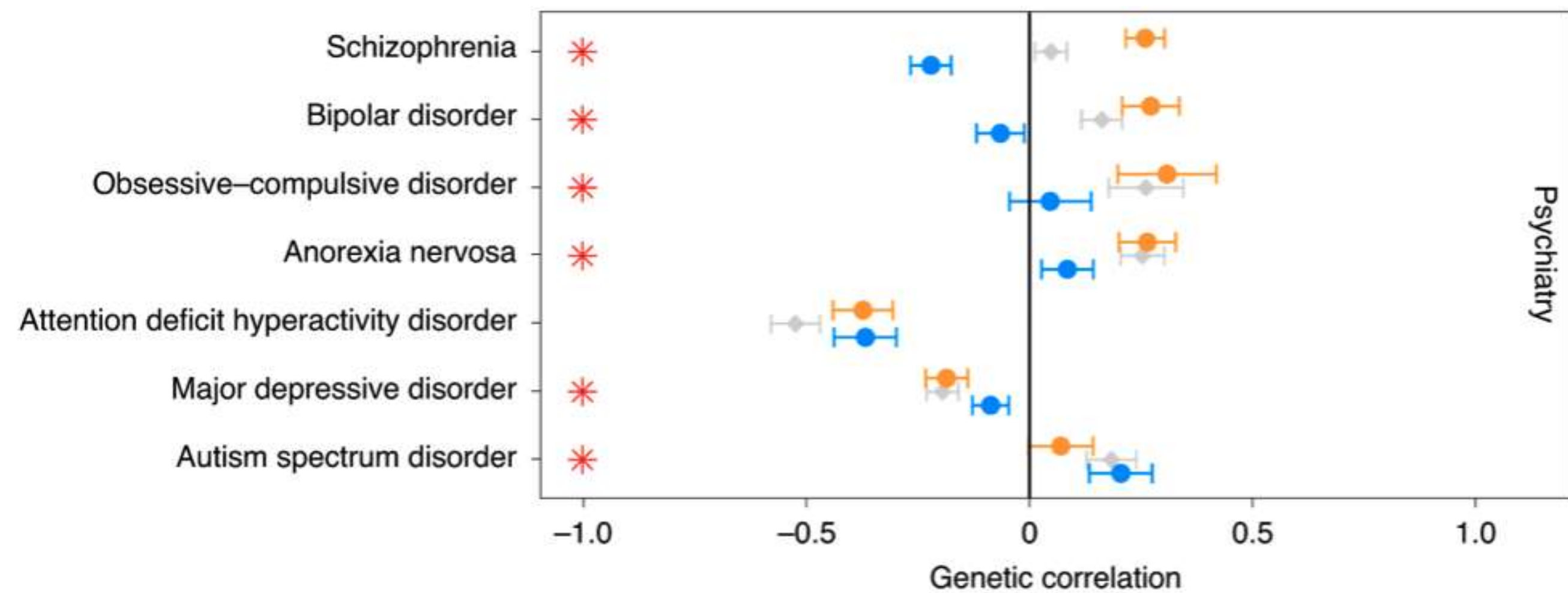
LUCK

WHAT ROLE HAS GENETIC CHANCE PLAYED IN YOUR LIFE?

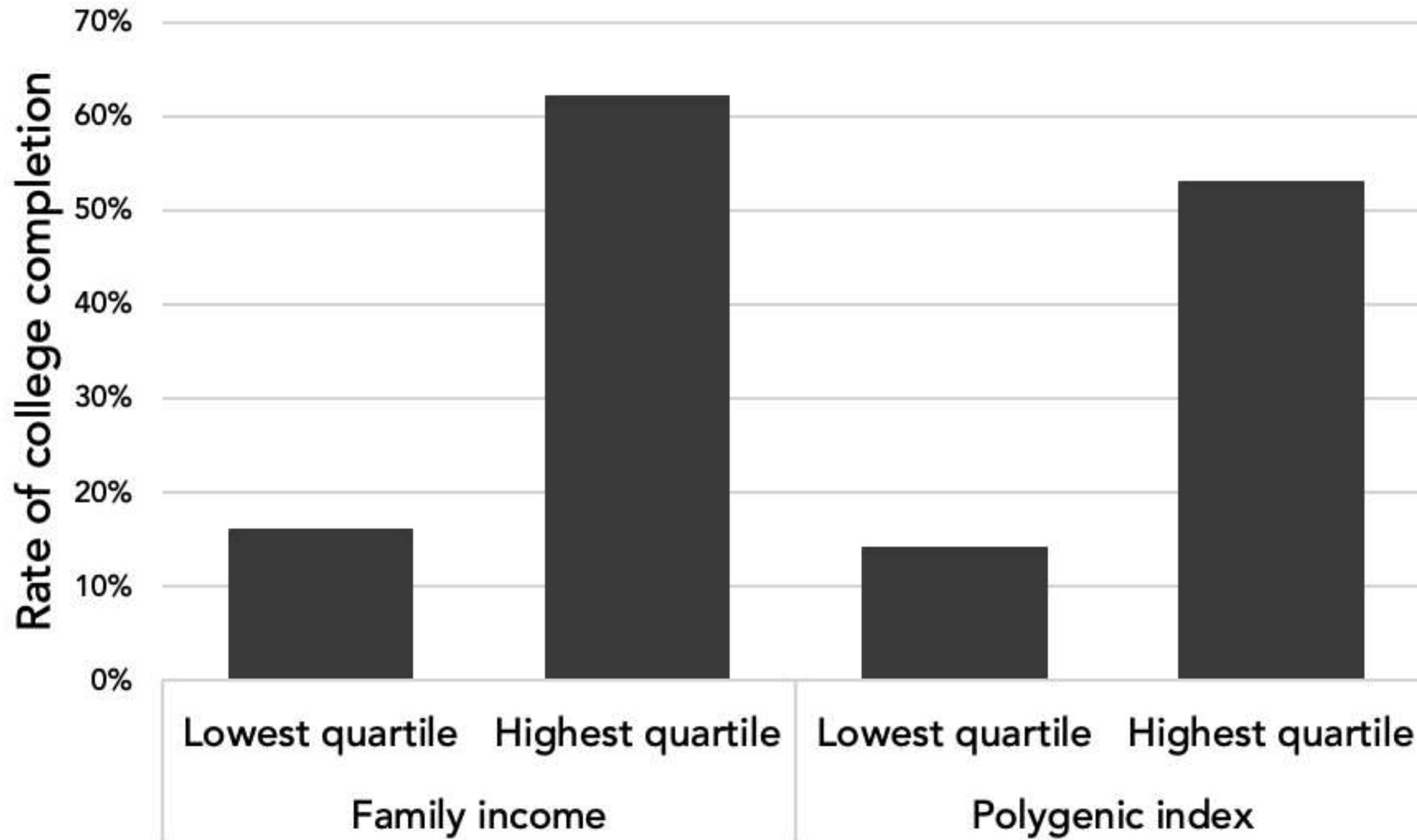


RECOMBINATION

During meiosis, each of your parent's chromosomes reshuffled to make new combinations of the DNA. You are 1 in 70 trillion.



Educational inequalities in the US

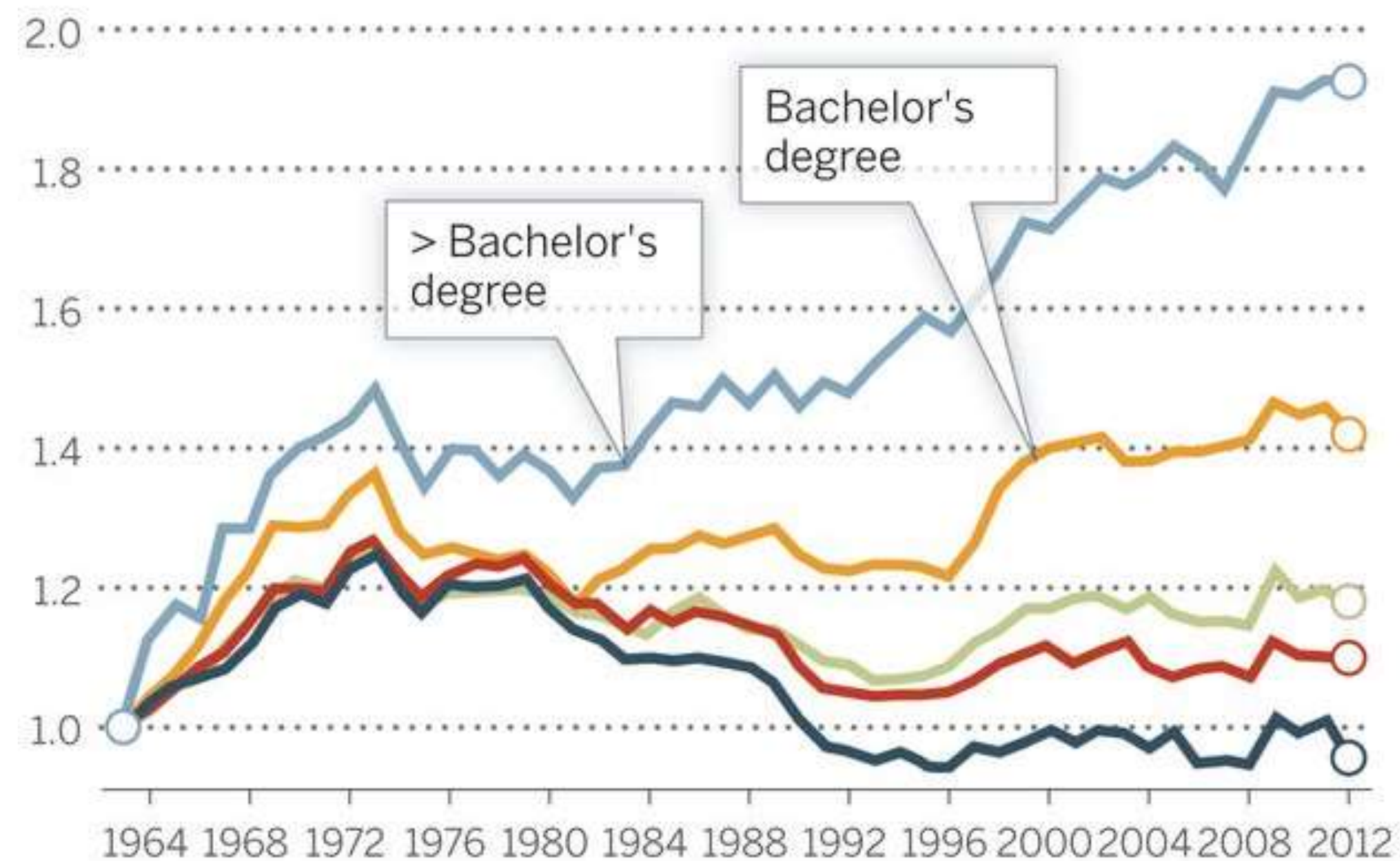


TWO LOTTERIES —

INEQUALITY BY EDUCATION

Real weekly earnings relative to 1963 (men)

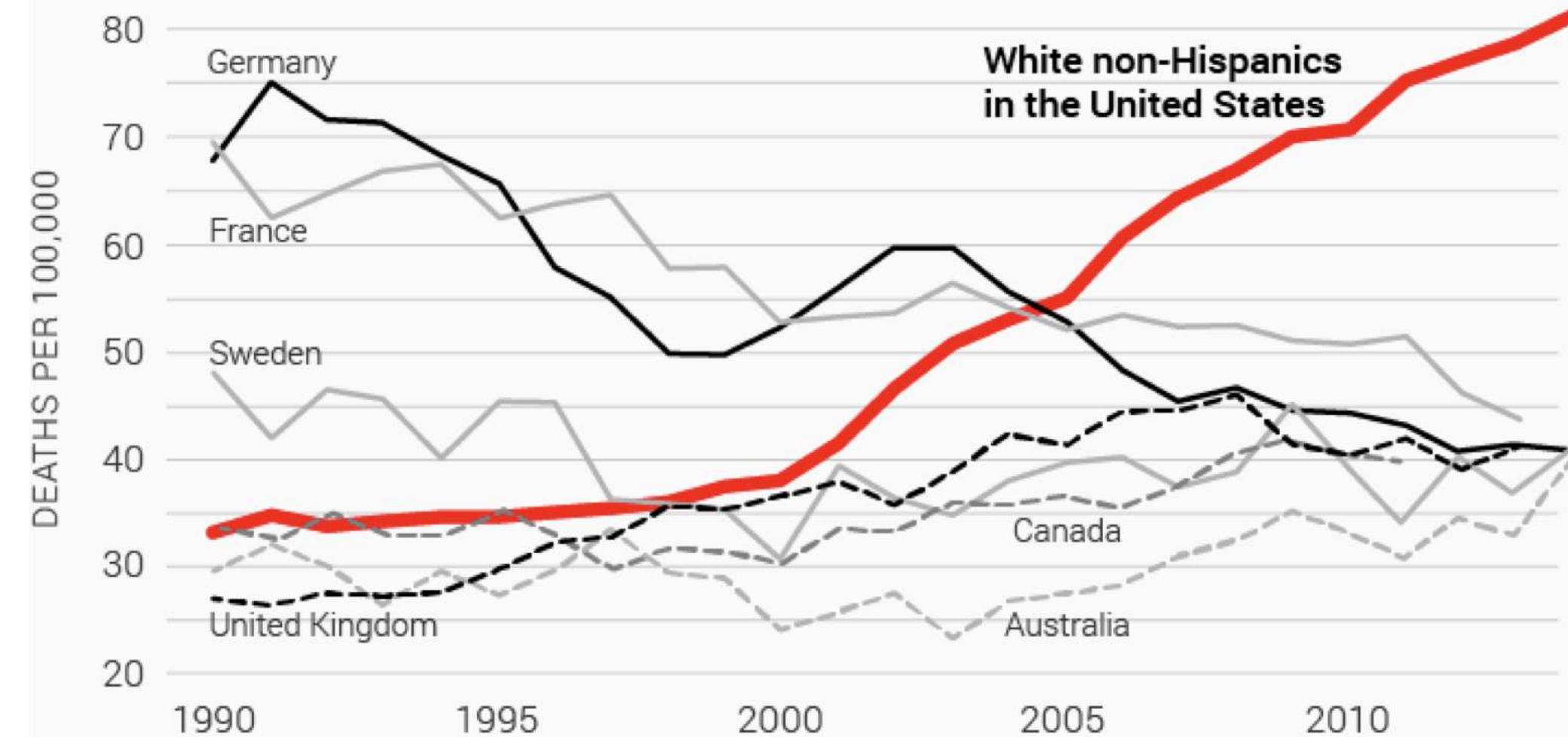
A



Autor 2014

Midlife mortality from "deaths of despair" across countries

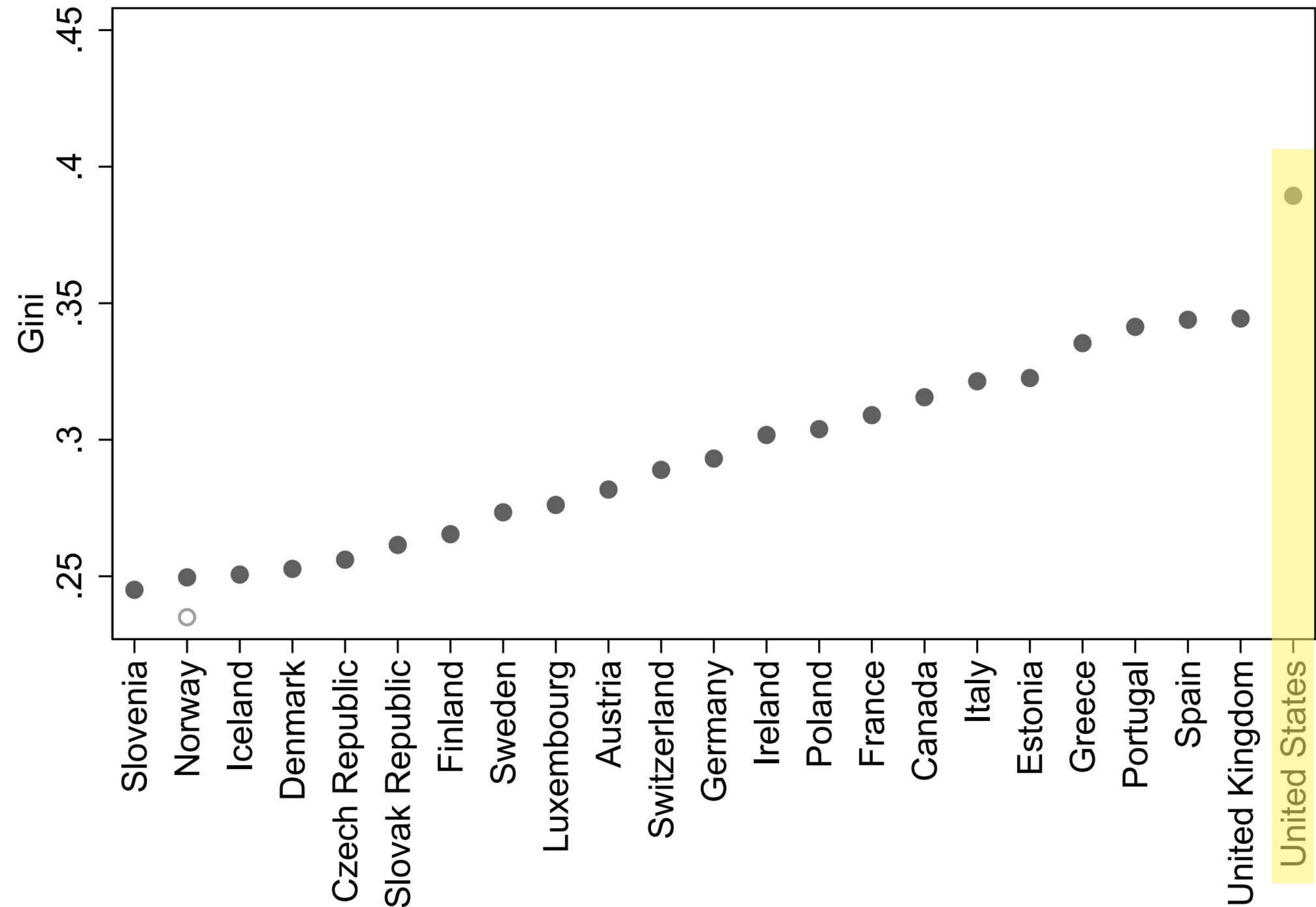
Men and women ages 50-54, deaths by drugs, alcohol, and suicide



Source: "Mortality and morbidity in the 21st century" by Anne Case and Angus Deaton, Brookings Papers on Economic Activity, Spring 2017.

B | Economic Studies
at BROOKINGS

Figure 1: Income inequality in OECD countries



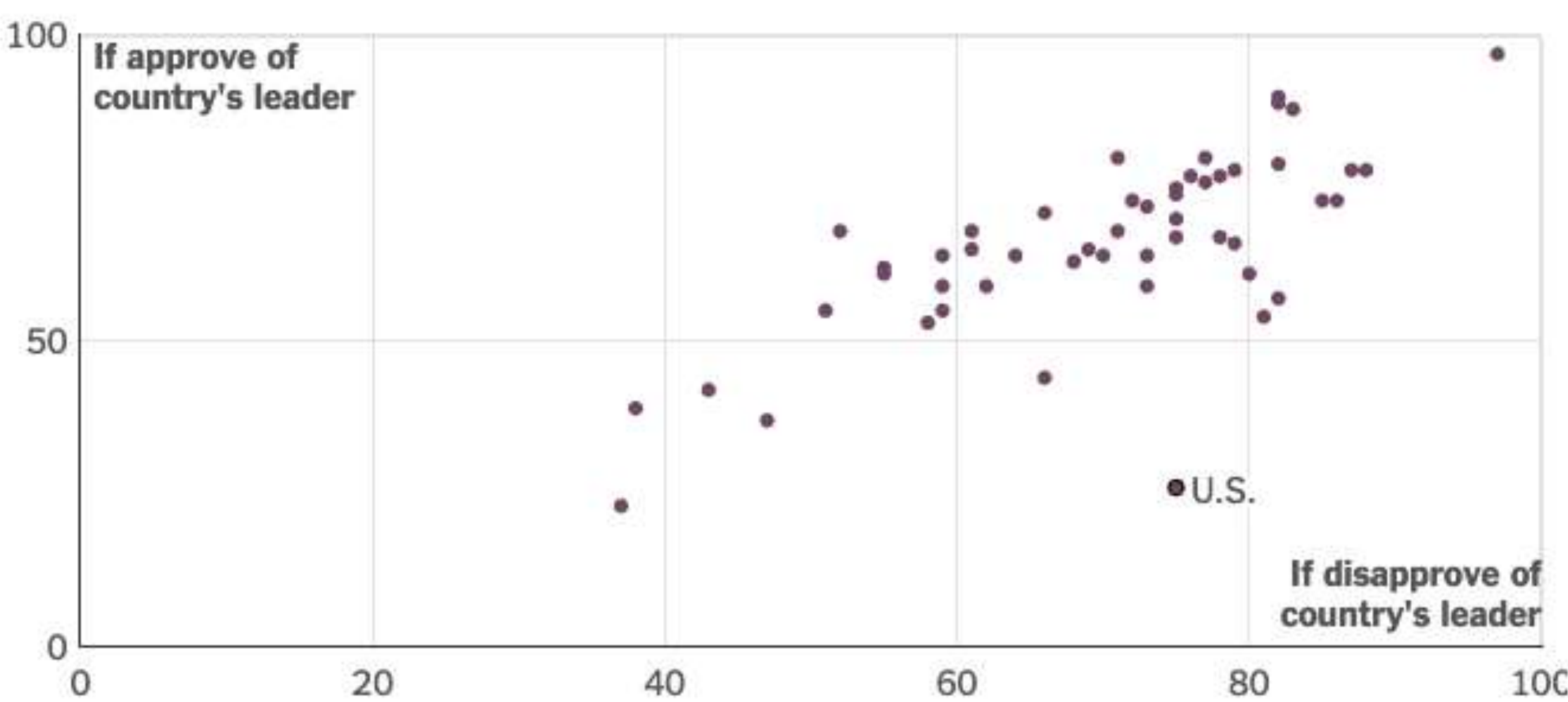
Do the Rich Deserve Their Riches?

Percentage of people agreeing with various explanations for income inequality.

	World population	U.S. Pro-Trump	U.S. Anti-Trump
Reasons for inequality that suggest rich may deserve higher income			
Rich work harder	32%	37	8
Rich are born with greater abilities	31%	20	26
Rich are more willing to delay gratification	46%	55	23
Rich are more willing to take risks	57%	66	32
Average agreement with these reasons	42%	45	22
Reasons for inequality that suggest rich may not deserve higher income			
Rich are luckier	47%	27	38
Rich are more selfish	53%	16	36
Rich provided greater familial opportunities	70%	60	82
Rich more likely to do illegal activity	52%	13	27
Average agreement with these reasons	55%	29	46

Pro-Trump Americans Are Global Outliers

Only 26 percent of Americans who approve of Mr. Trump say income differences between rich and poor are unfair. The percent who say unfair:



Source: Gallup World Poll • By The New York Times

“Luck is not something you can mention
in the presence of self-made men.”

E.B. WHITE, *ONE MAN’S MEAT*

Cutthroat capitalism versus cuddly socialism: Are Americans more meritocratic and efficiency-seeking than Scandinavians?

Ingvild Almås

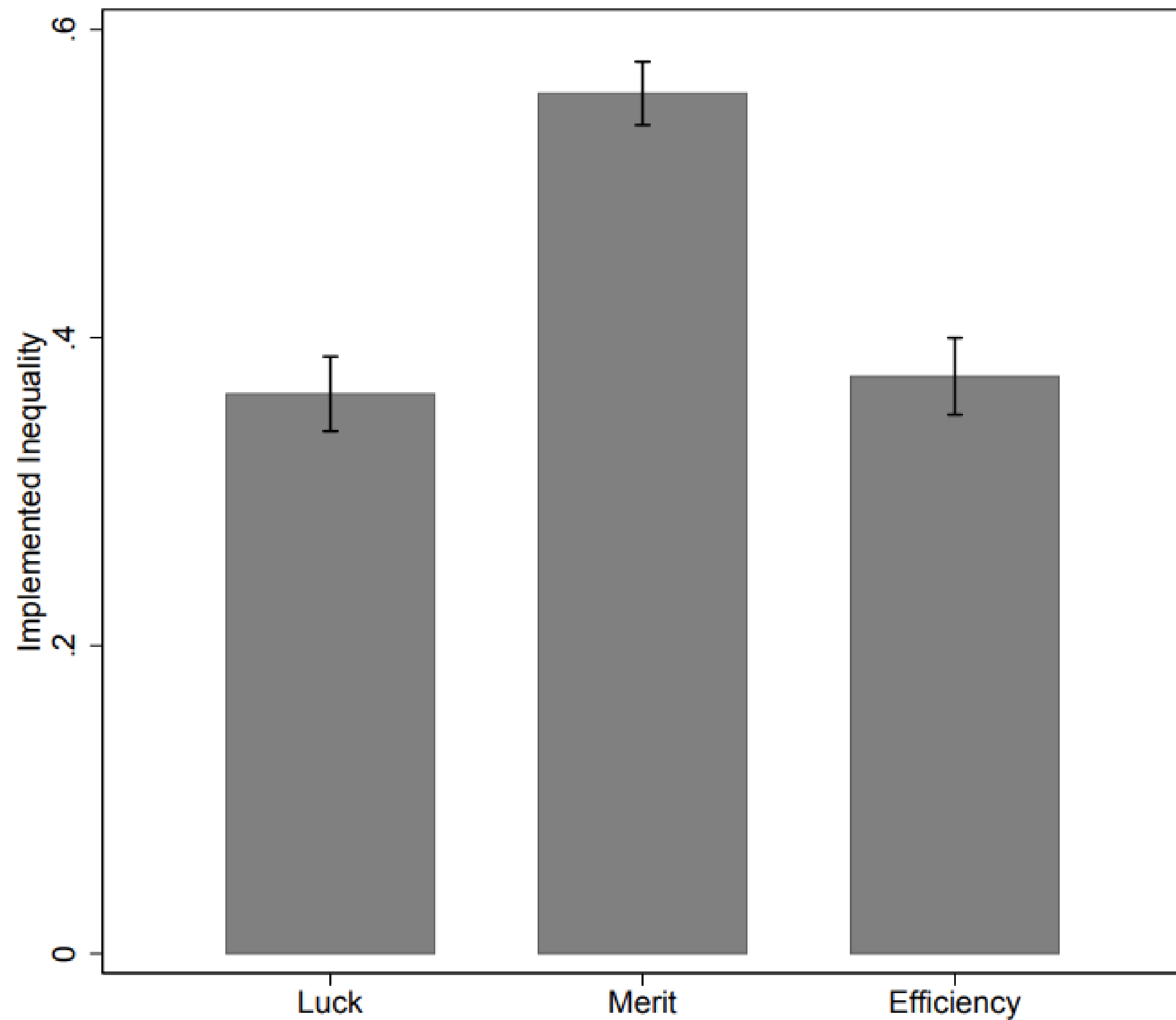
Alexander W. Cappelen

Bertil Tungodden*

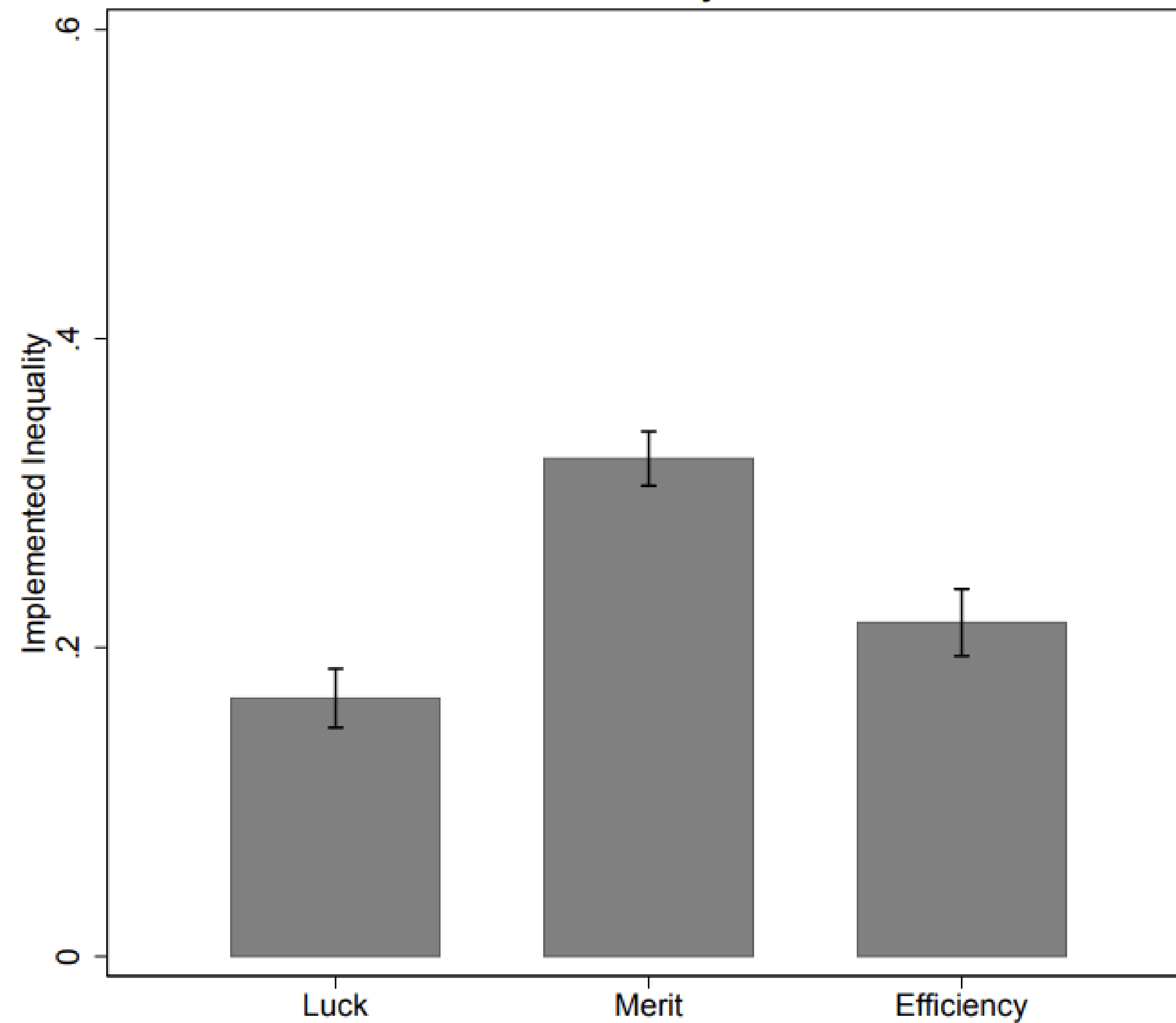
Table 1: Sequence of events in the experiment

Stage of experiment
1. Work stage: Workers complete an assignment.
2. Earnings stage: Workers matched in pairs. Assigned initial earnings according to treatment.
3. Redistribution stage: Each spectator decides for one pair of workers whether and how much to redistribute.
4. Payment stage: Workers in the pair paid according to the decision of the spectator.

United States



Norway



“Once we are troubled by the influence of either social contingencies or natural chance on the determination of distributive shares, we are bound, on reflection, to be bothered by the influence of the other. From a moral standpoint the two seem equally arbitrary.”

JOHN RAWLS, *A THEORY OF JUSTICE*

WORK

H

ARE SOME PEOPLE “NATURALLY” BETTER THAN OTHERS?

“Unfortunately, there is an old and perhaps permanent danger that inquiries into the genetic differences among us will be appropriated to justify inequalities in the distribution of social power.”

ERIK PARENS, THE HASTINGS CENTER



ANTI-EUGENICS

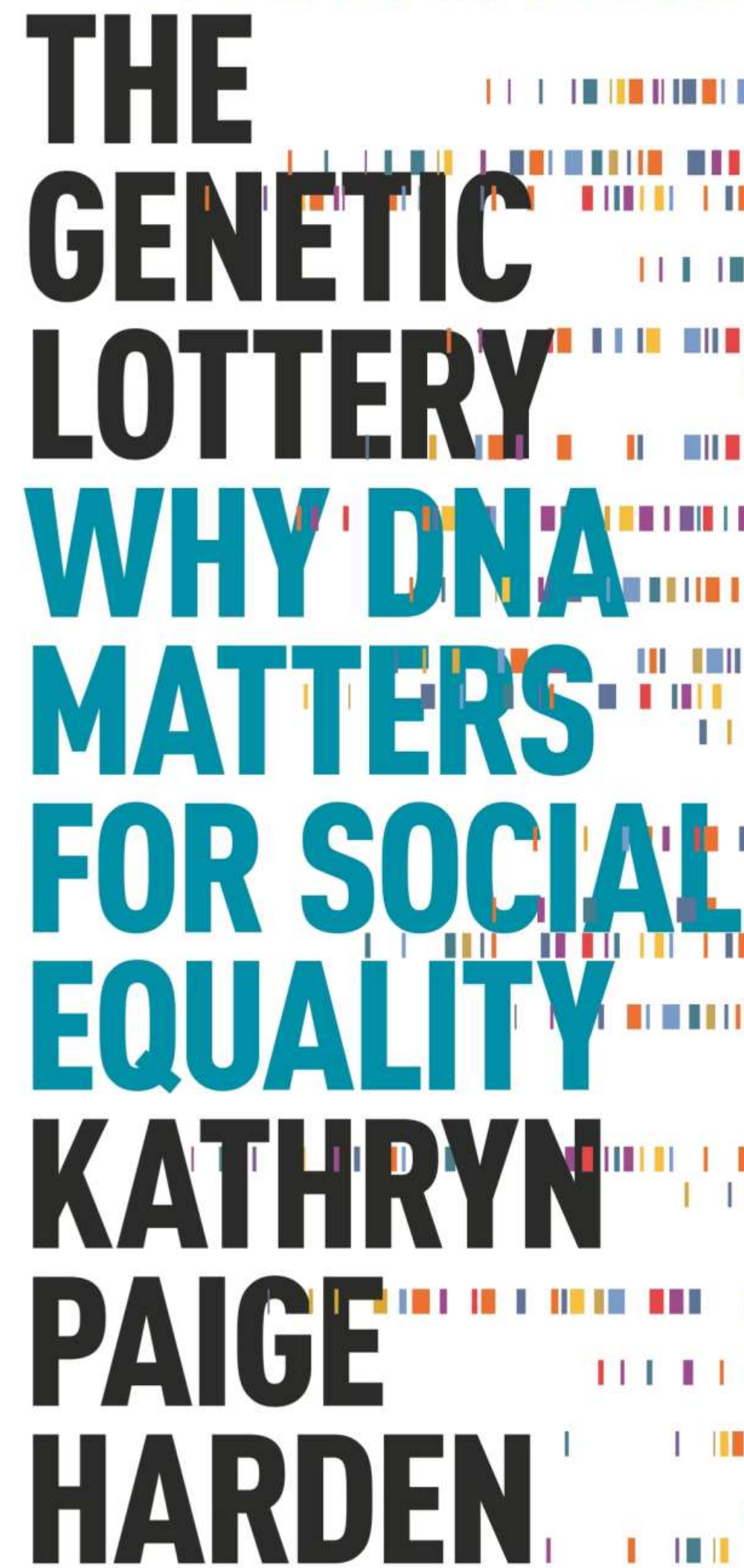
We know what anti-eugenic buildings look like ...

What does an anti-eugenic economy look like?
Education system? Health care system?



“Genetic diversity is mankind’s most precious resource, not a regrettable deviation from an ideal state of monotonous sameness.”

THEODOSIUS DOBZHANSKY, “GENETICS AND EQUALITY”, *SCIENCE*



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QUESTI
ONS?

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