The role of gene-environment interplay in educational outcomes

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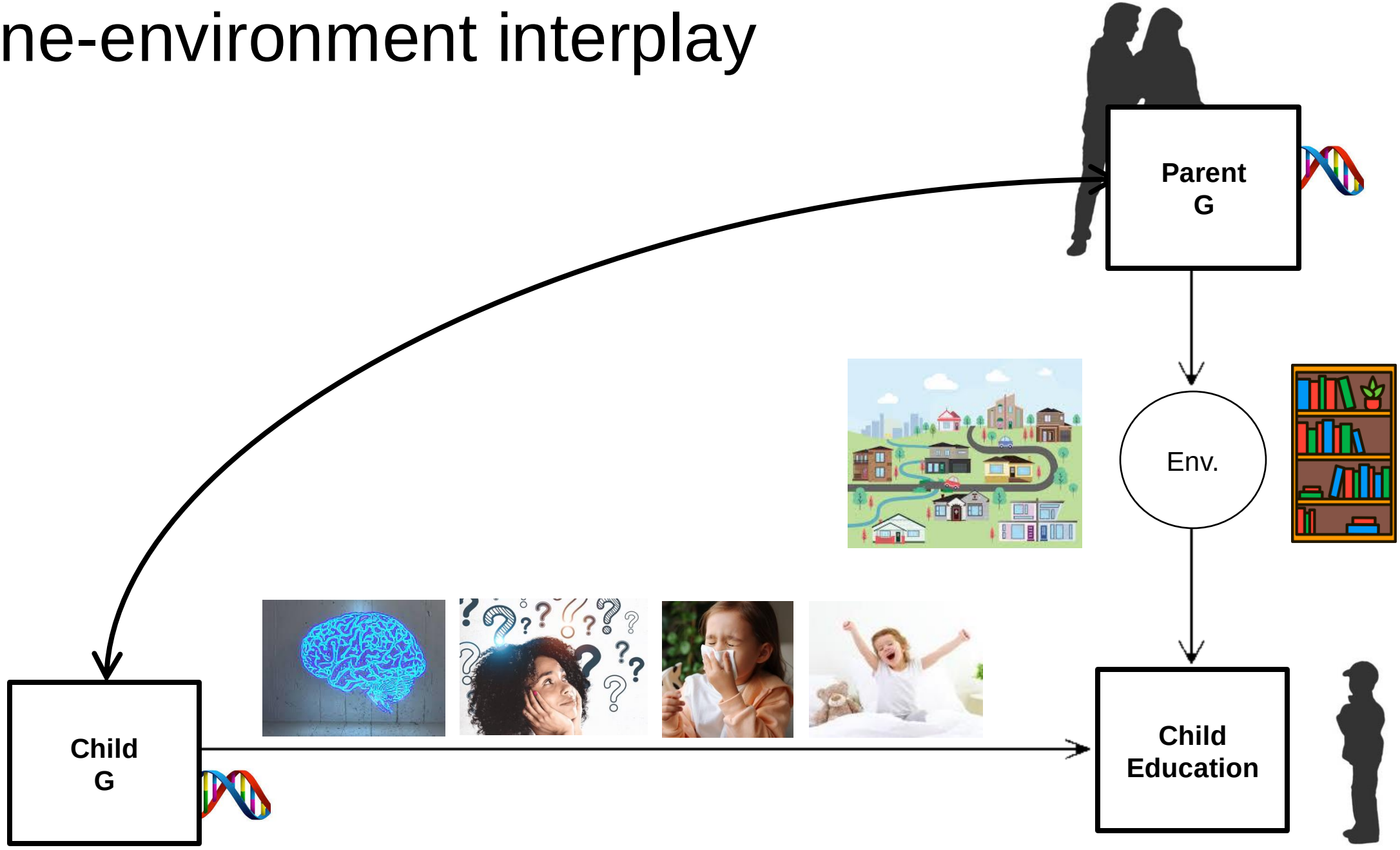
Summary

1. Background on gene-environment interplay research in education
   - Key theories
   - Key developments in the field

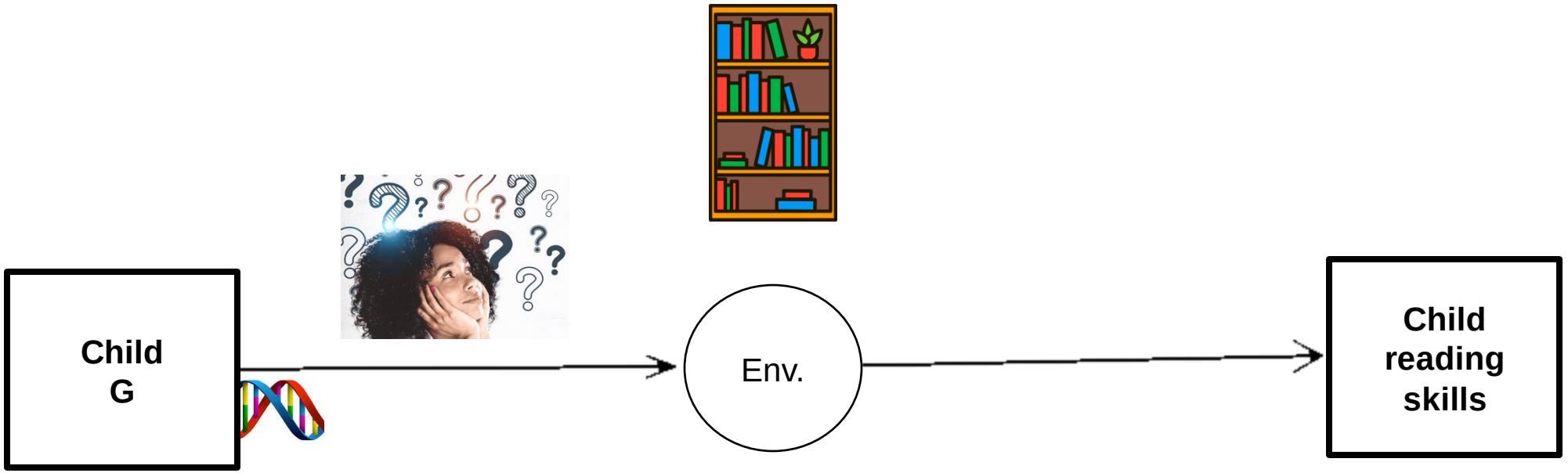
2. Using genetics to understand:
- Parental effects on offspring education
- Horizontal educational stratification

Gene-environment interplay

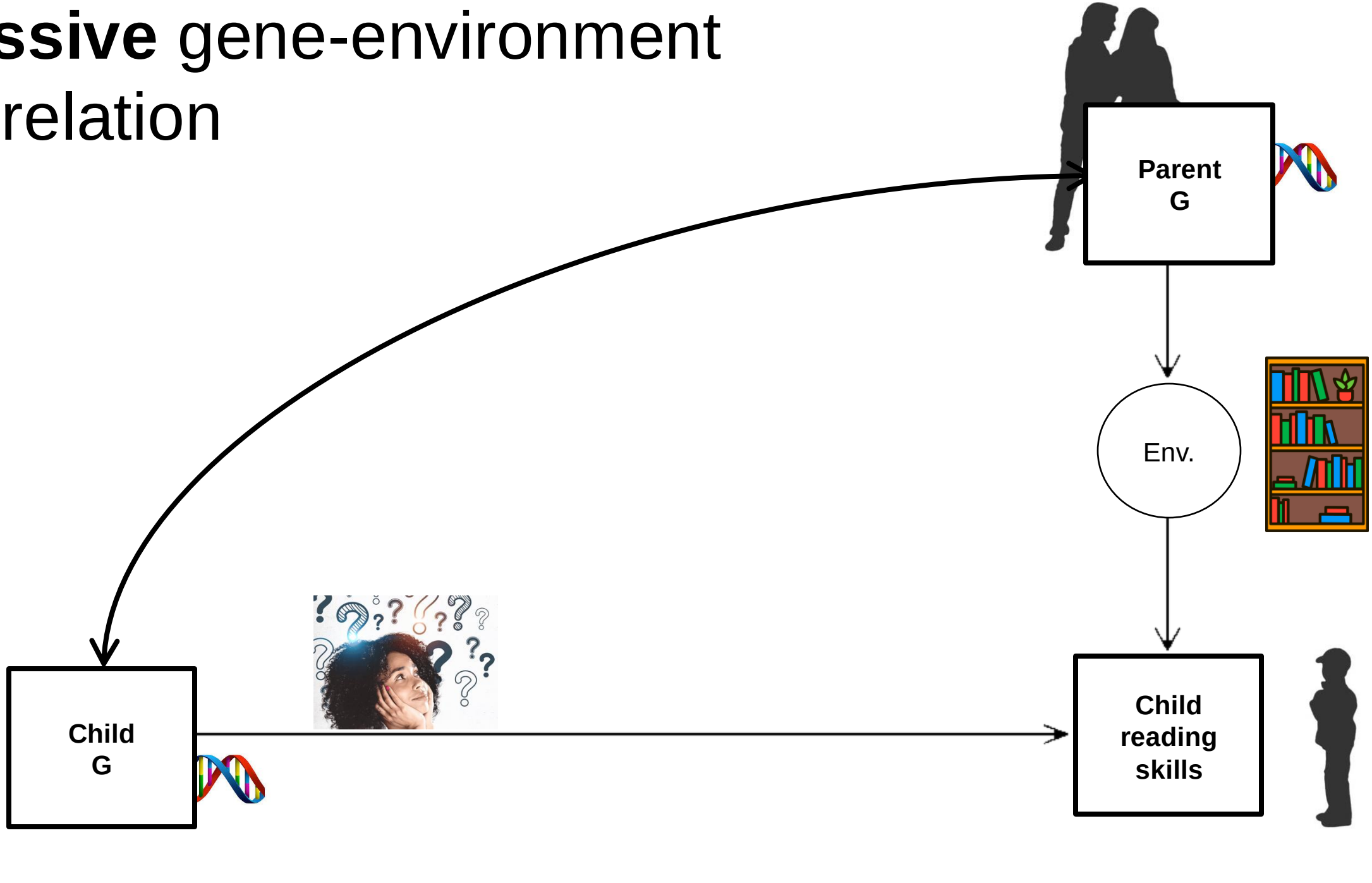


Plomin et al. 1977 Analysis of gene-environment correlation and interaction in human behaviour

Active/evocative gene-environment correlation



Passive gene-environment correlation



Gene-environment interaction vs gene-environment correlation

- r(G, E): **how we shape our experiences**; correlations between genetic and environmental factors
- G * E interaction: **how experiences modify our genetic expression** (and vice versa); effects of genetic factors are moderated by social factors (and vice versa)
- Much stronger evidence base for r(G,E) than G*E

Key developments in gene-environment interplay research in education

1. Twin and family studies

BEHAVIORAL AND BRAIN SCIENCES (1991) 14, 373–427
Printed in the United States of America

The nature of nurture: Genetic influence on "environmental" measures

Robert Plomin[a] and C. S. Bergeman[b]

Education policy and the heritability of educational attainment

A. C. Heath*, K. Berg†, L. J. Eaves*, M. H. Solaas†, L. A. Corey*, J. Sundet‡, P. Magnus† & W. E. Nance*

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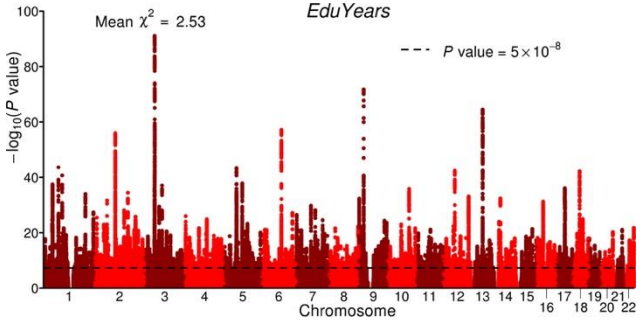
2. Genomics



The continuing value of twin studies in the omics era

Jenny van Dongen, P. Eline Slagboom, Harmen H. M. Draisma, Nicholas G. Martin & Dorret I. Boomsma

3. Family-based socio-genomics

RESEARCH ARTICLE

The nature of nurture: Effects of parental genotypes

AUGUSTINE KONG, GUDMAR THORLEIFSSON, MICHAEL L. FRIGGE, BJARNI J. VILHJALMSSON, [...], AND KARI STEFANSSON +10 authors Auth

HUMAN GENOMICS

2018

The nature of nurture: Effects of parental genotypes

Augustine Kong,[1,2,3]* Gudmar Thorleifsson,[1] Michael L. Frigge,[1]

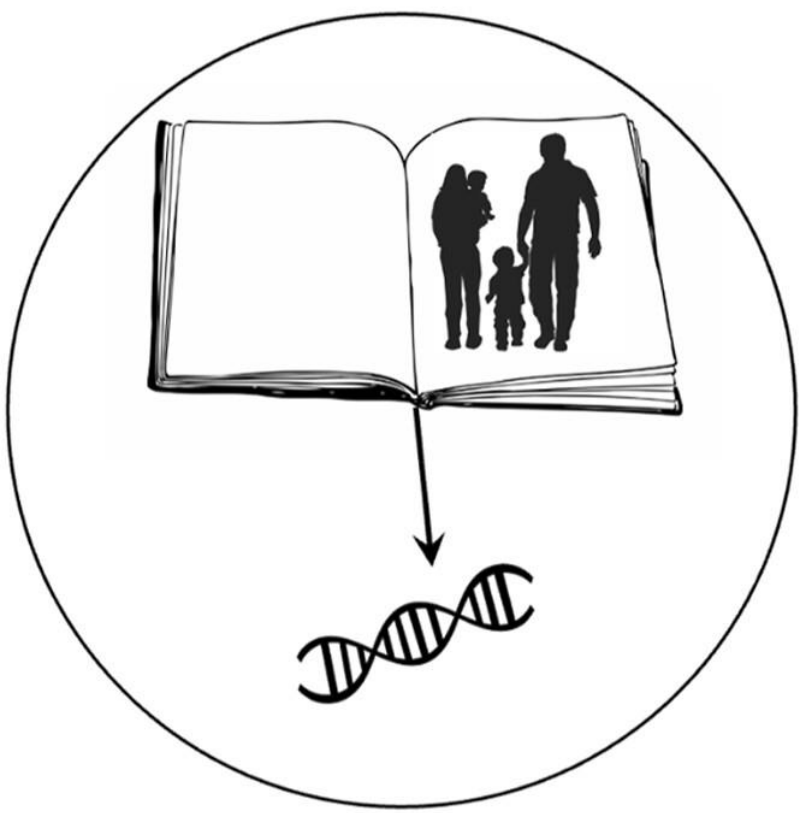
Effects of non-transmitted genetic variants capture "genetic nurture"

BEHAVIORAL AND BRAIN SCIENCES (1991) 14, 373–427
Printed in the United States of America

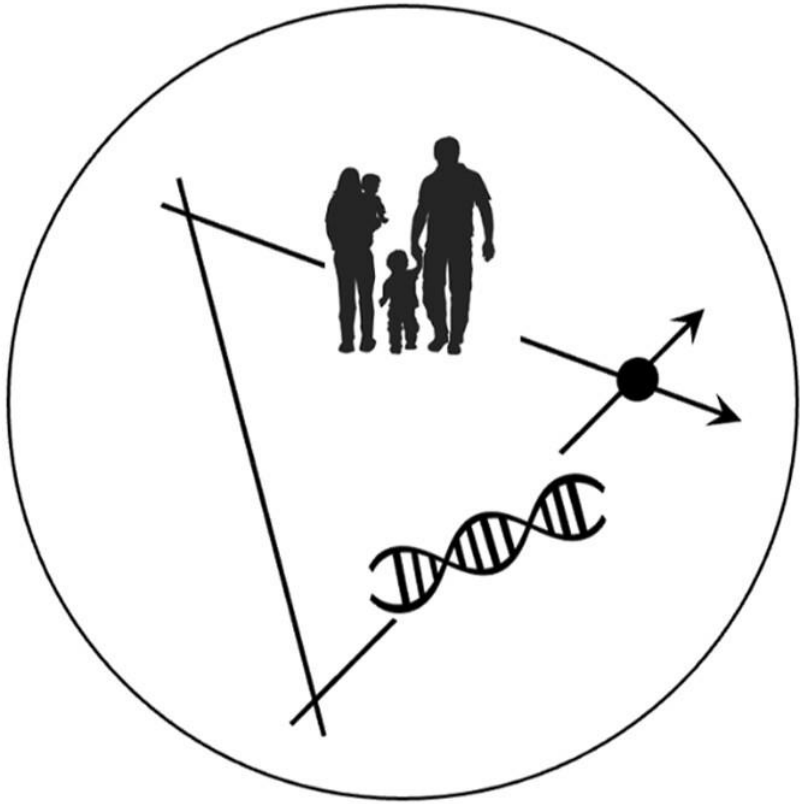
The nature of nurture: Genetic influence on "environmental" measures

Robert Plomin[a] and C. S. Bergeman[b]

"gene-environment correlation"
"parental indirect genetic effect"
"dynastic effects"



Using knowledge



Triangulating

Integrating

Cheesman et al. 2023 *JCPP Advances* Why we need families in genomic research on developmental psychology

Summary

1. Background on gene-environment interplay research in education
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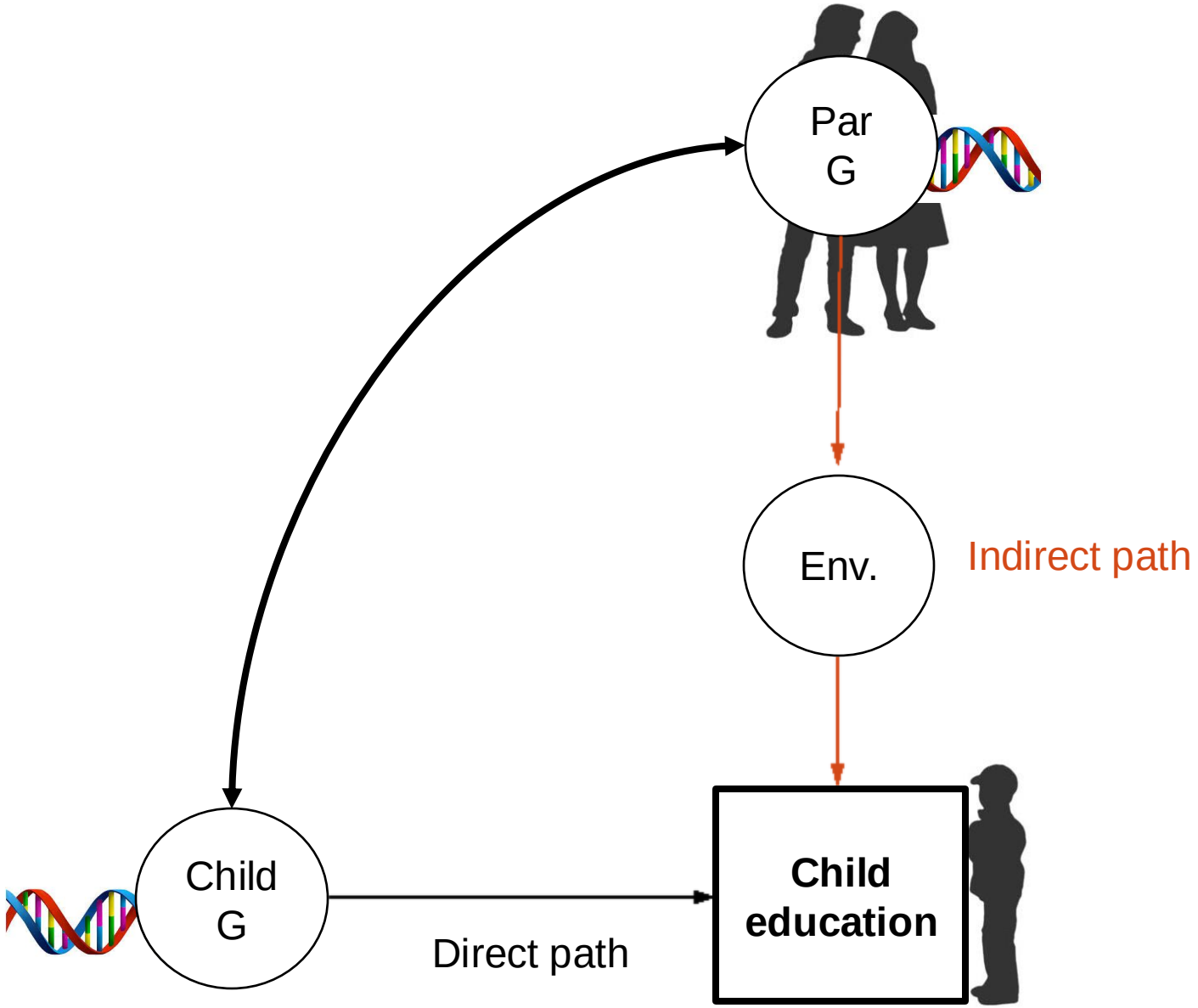
2. Using genetics to understand:
   - Parental effects on offspring education
   - Horizontal educational stratification

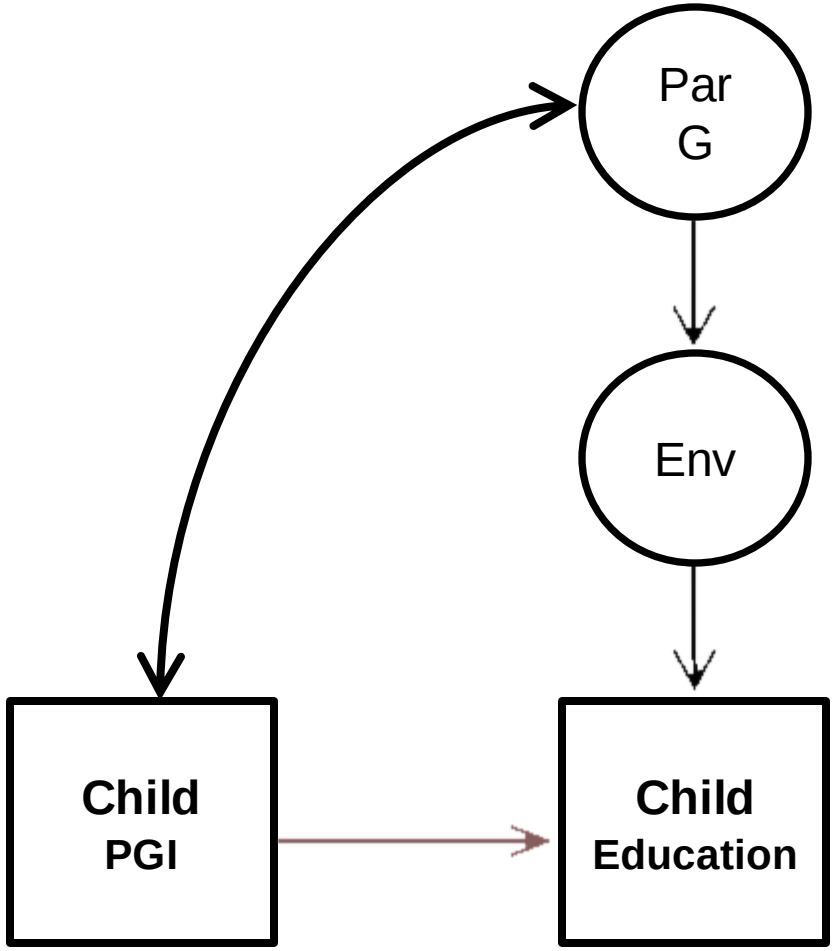
1. Using genetics to understand parental effects



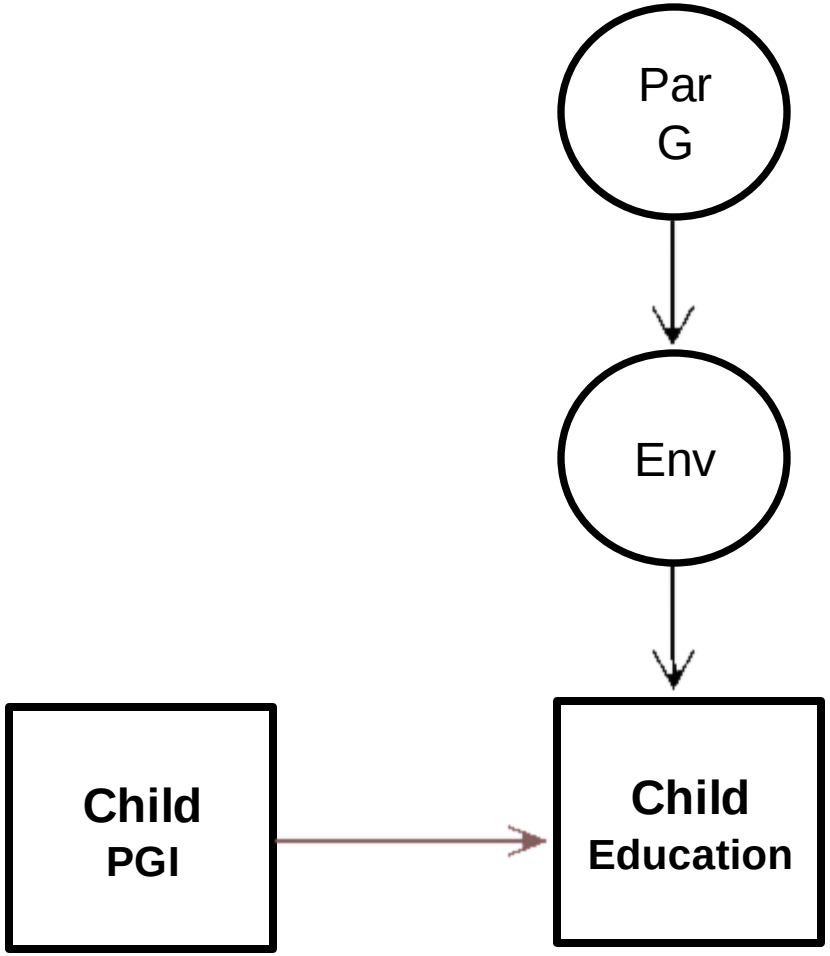
Strengths of 'genetic nurture' approach:

1. *Explains substantial variance (7%; Young et al. 2018)*
2. *No need to assess parenting; latent effect*
3. *Large sample size, not biased by selective dropout*
4. *Controls for confounding due to shared genes*
5. *No issue with reverse causality*

1. Using genetics to understand parental effects



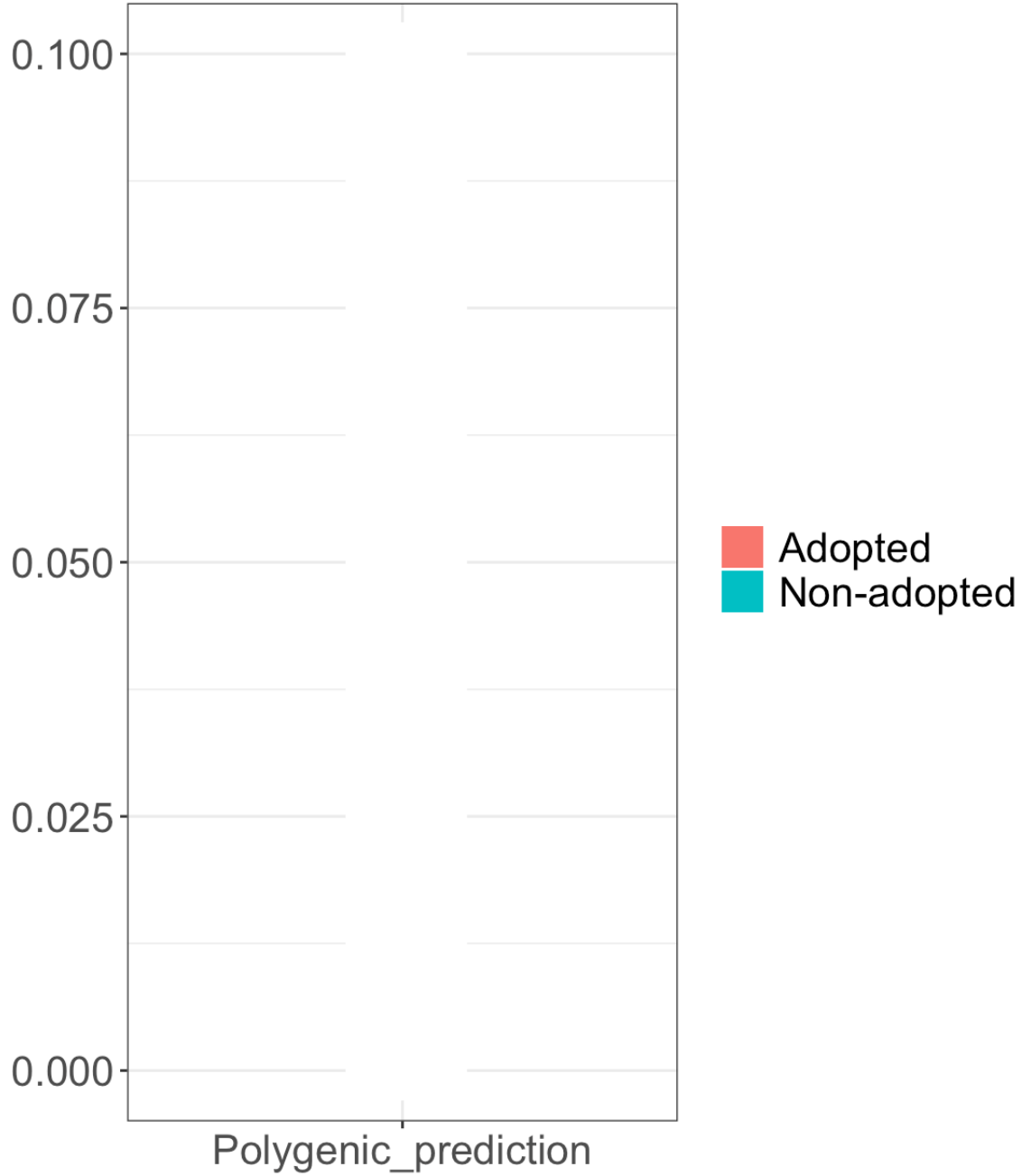
Non-adopted



Adopted

1. Using genetics to understand parental effects

variance explained in **educational attainment** (R^2)



biobank uk

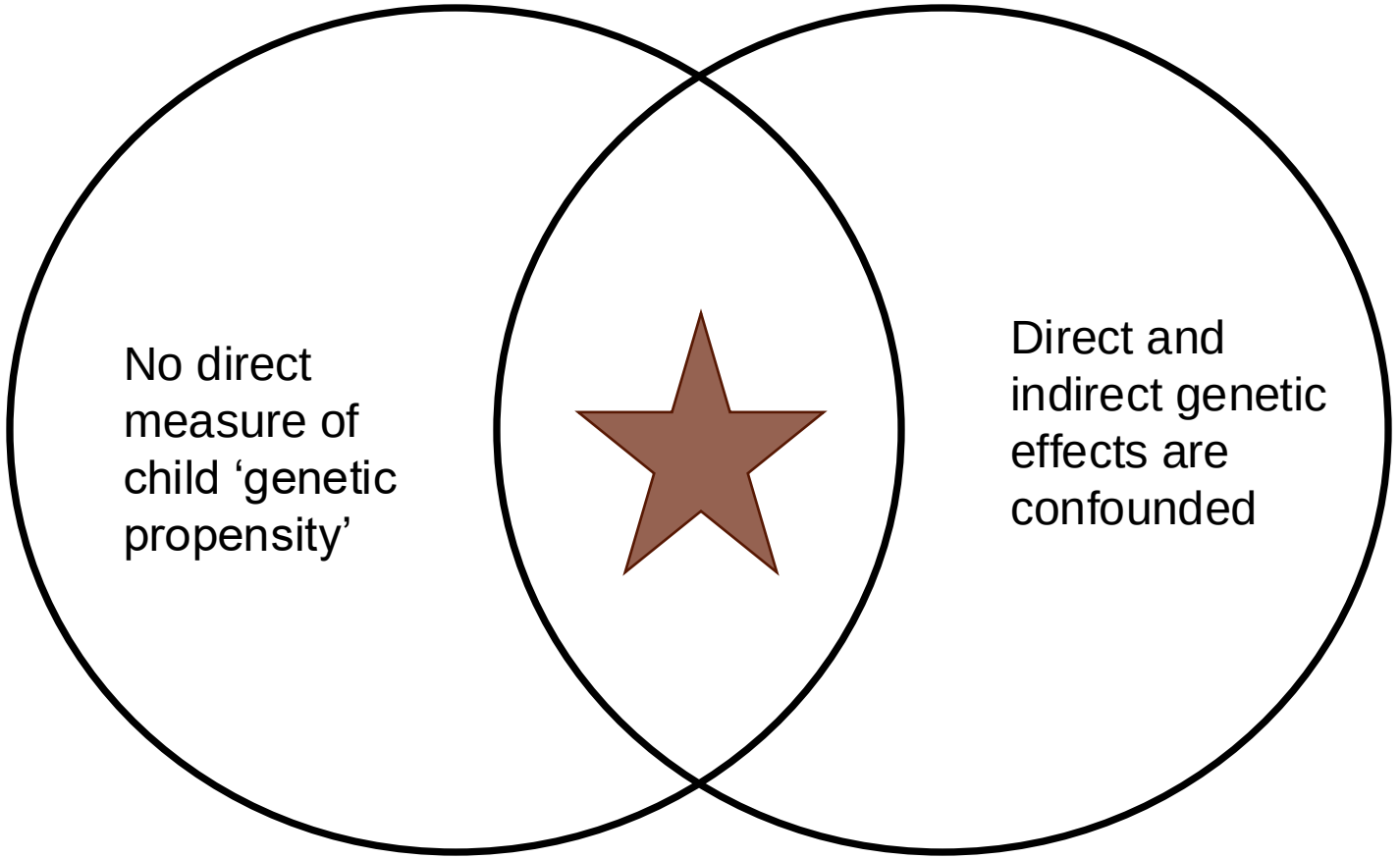
N = ~500,000

“Were you adopted as a child?” Yes N=7,342

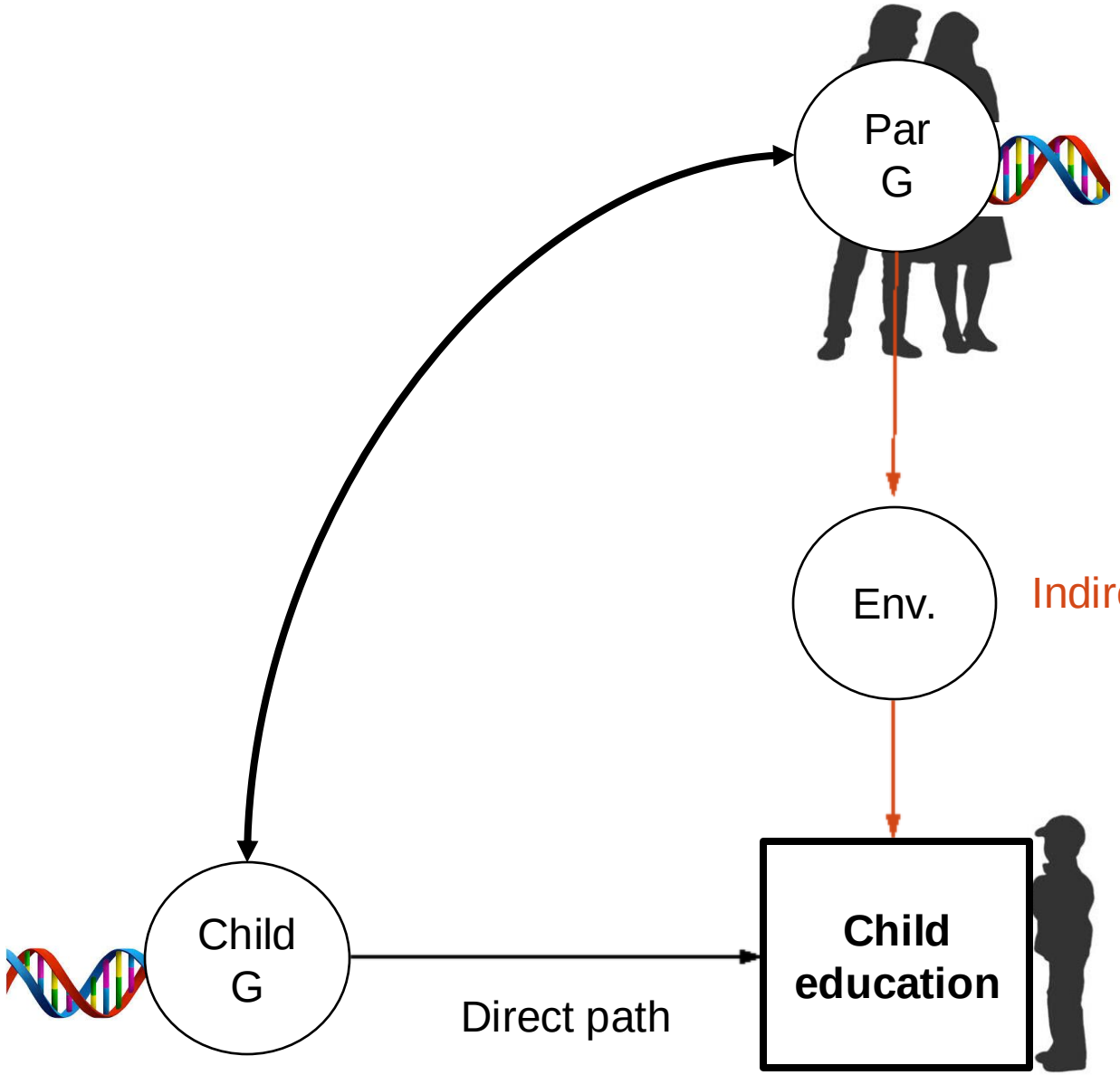
Cheesman et al. 2020 *Psych. Science*

1. Using genetics to understand parental effects

Traditional adoption design + Naïve polygenic index design



1. Using genetics to understand parental effects



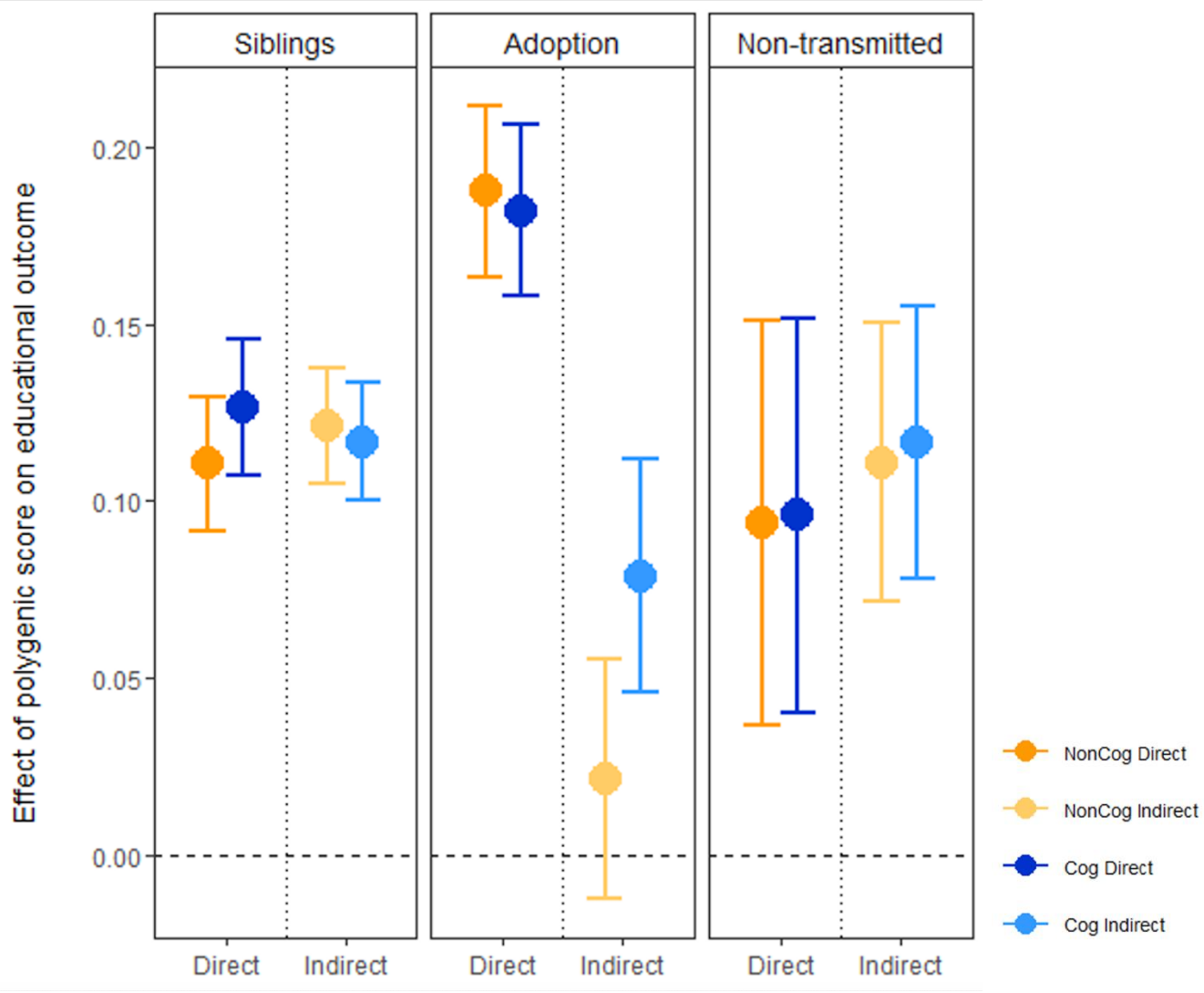
Multiple possible confounders and components

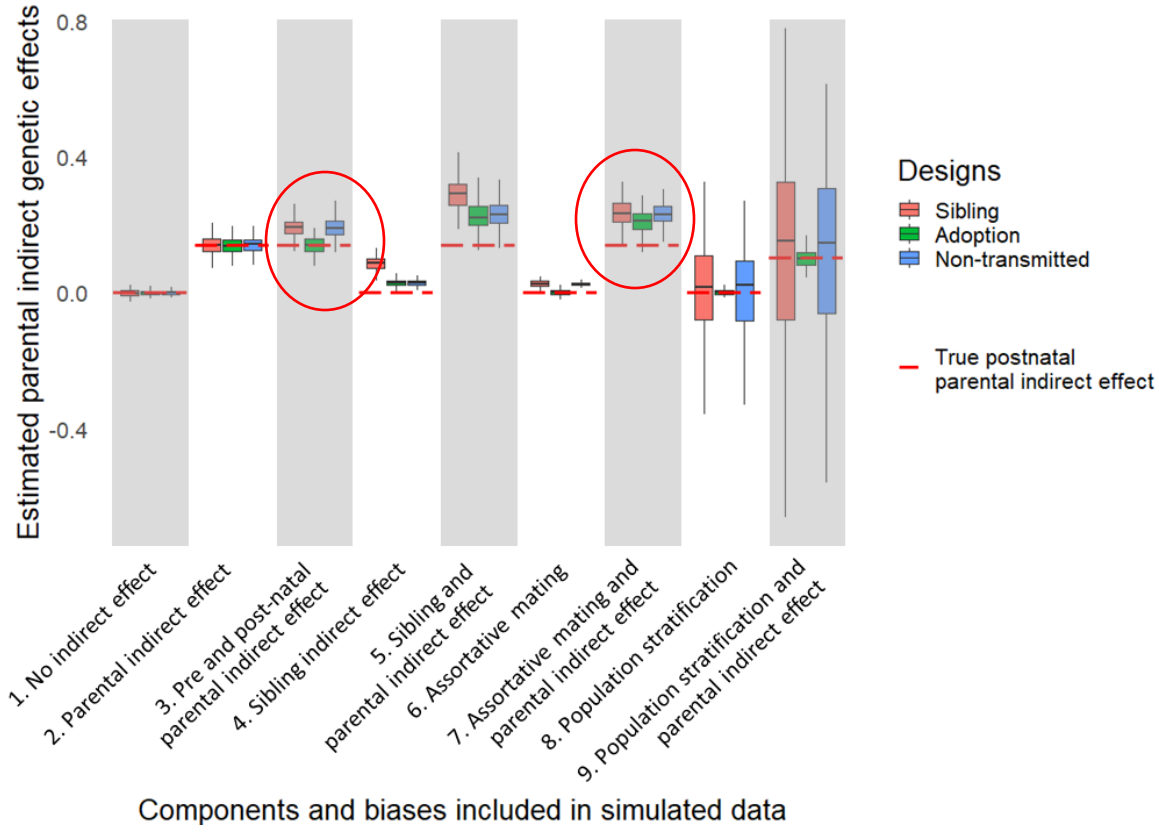
Proximal and distal environmental mechanisms

Cheesman et al. 2020 *Psych Sci;* Demange et al. 2022 *Nat Comm*

1. Using genetics to understand parental effects

Triangulation + simulations

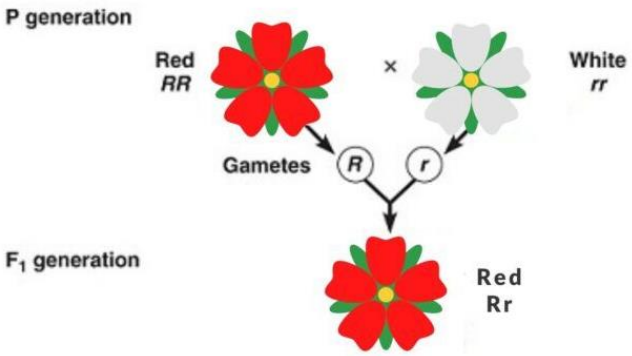


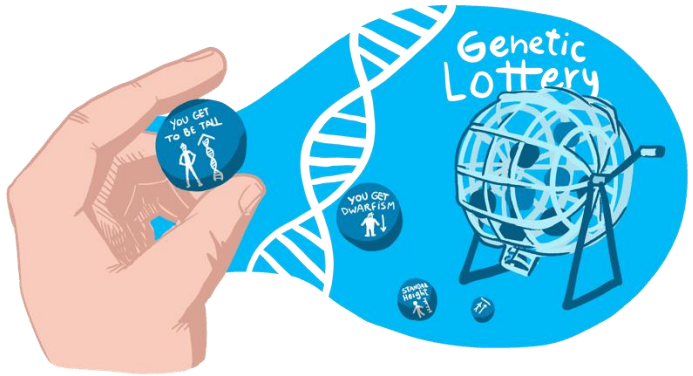


Data: UKB, TEDS, NTR

Demange et al. 2022

MENDELIAN SEGREGATION





a diploid organism passes a randomly selected allele for a trait to its offspring

2. Using genetics to understand horizontal stratification

Van de Werfhorst & Kraaykamp 2001; Gerber & Cheung 2008

ISCED FIELDS OF EDUCATION AND TRAINING 2013 (ISCED-F 2013)

Norway
N= 125,016

Finland
N= 338,118

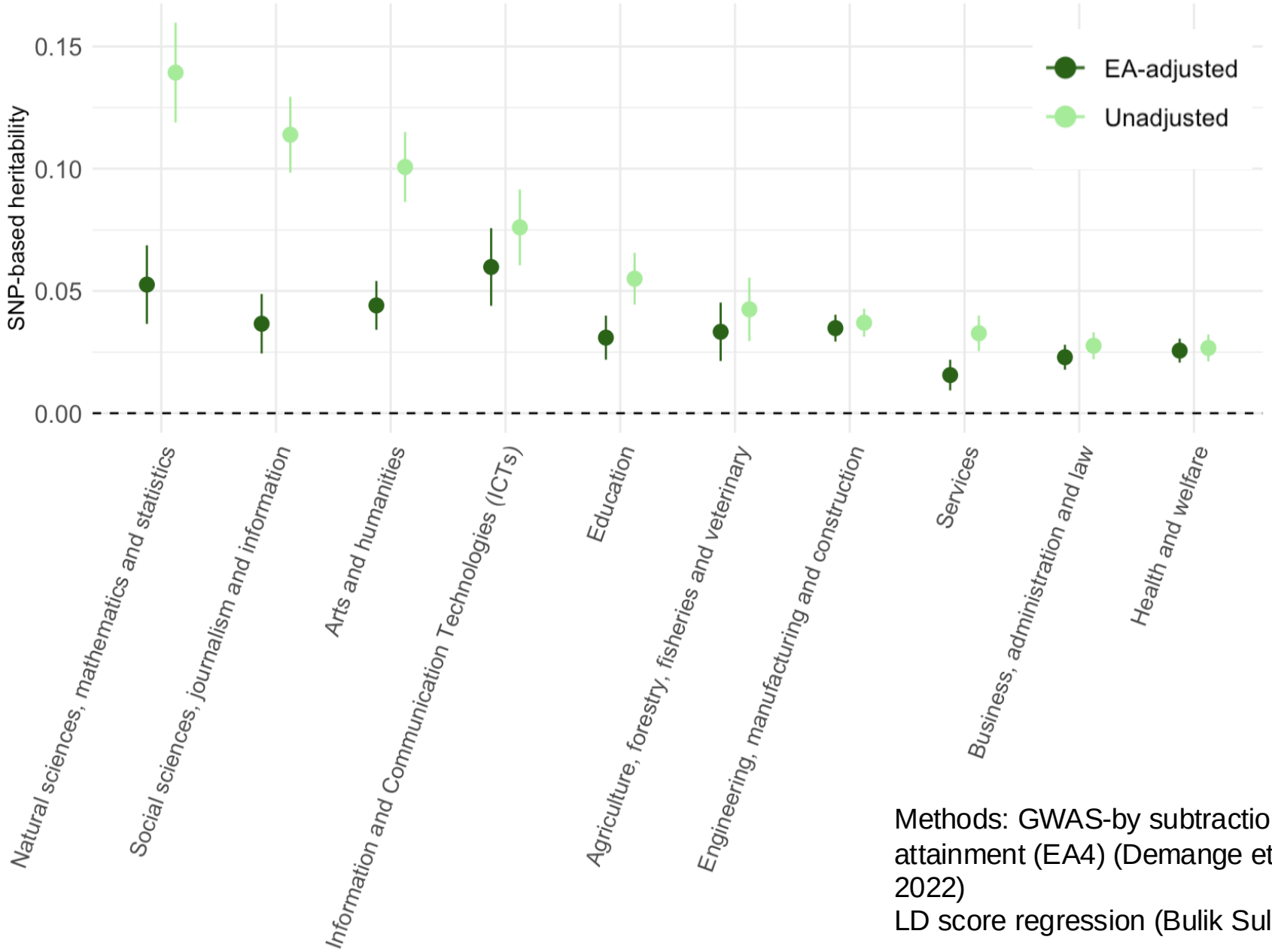
Netherlands
N= 36,373

moba

FINNGEN

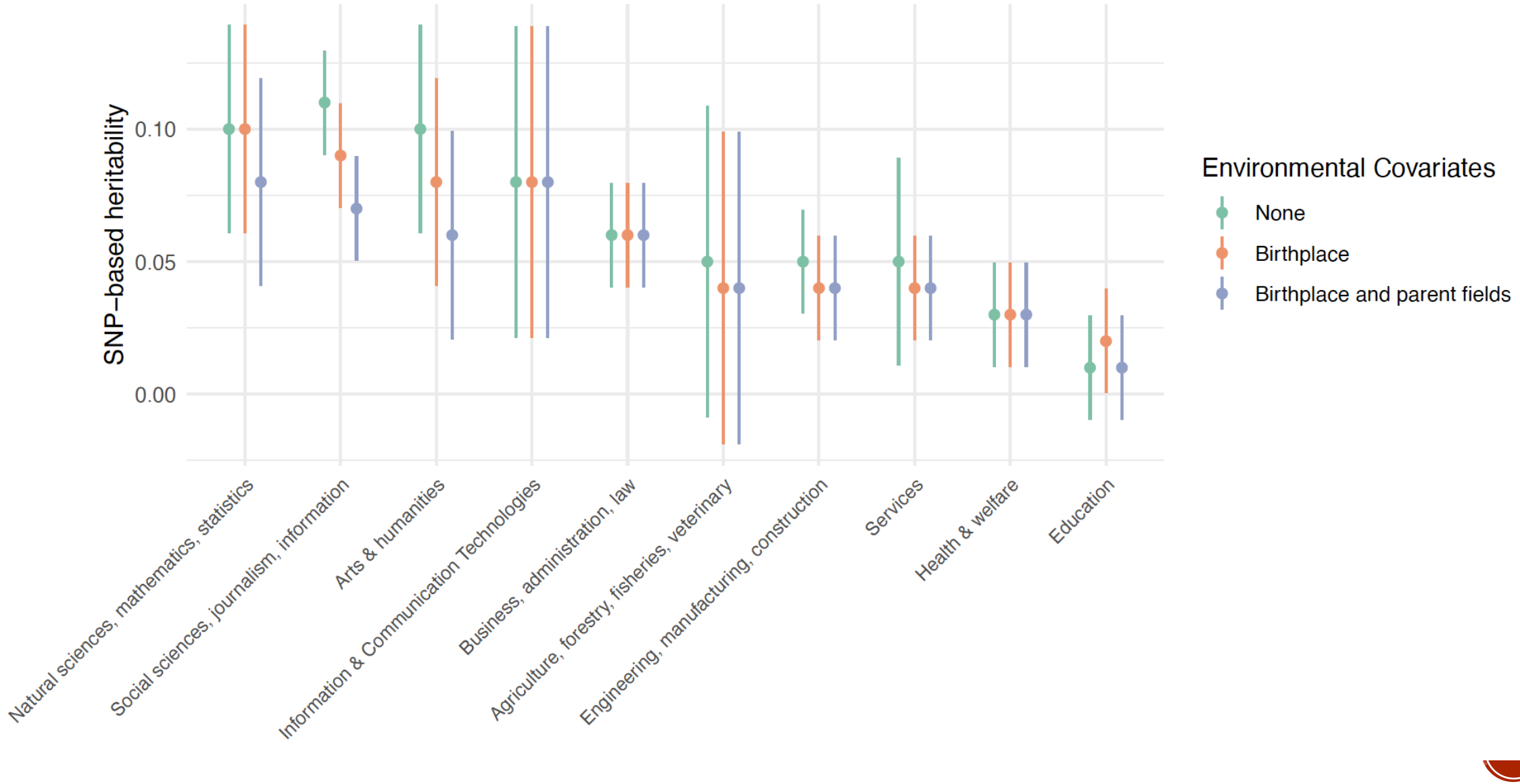
lifelines

SNP-based heritability estimates for fields of education

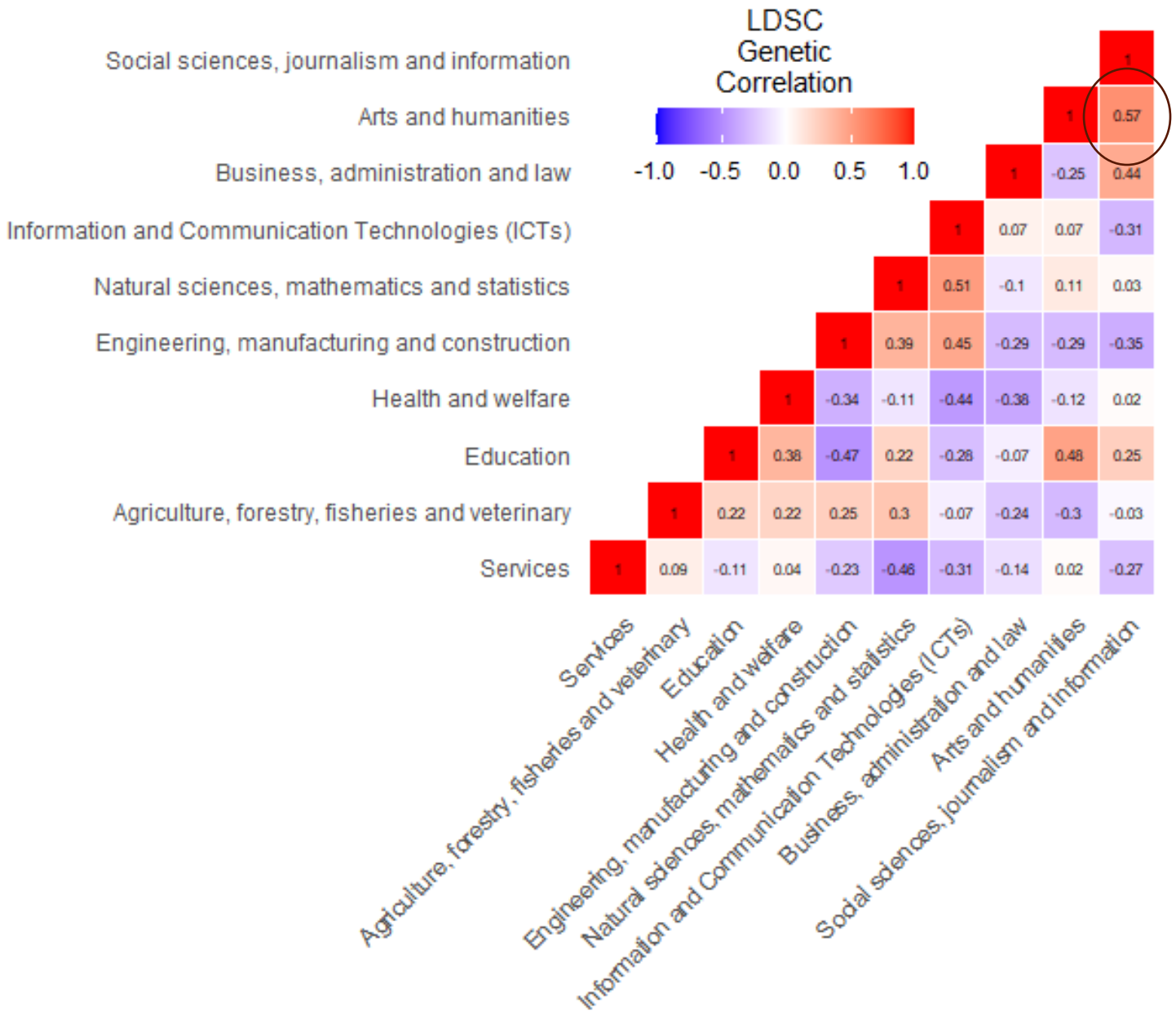


Methods: GWAS-by subtraction with educational attainment (EA4) (Demange et al. 2021; Okbay et al. 2022)
LD score regression (Bulik Sullivan et al. 2015)

Heritability estimates are not significantly reduced when adjusting for birthplace and parents' fields of education (Norwegian data)

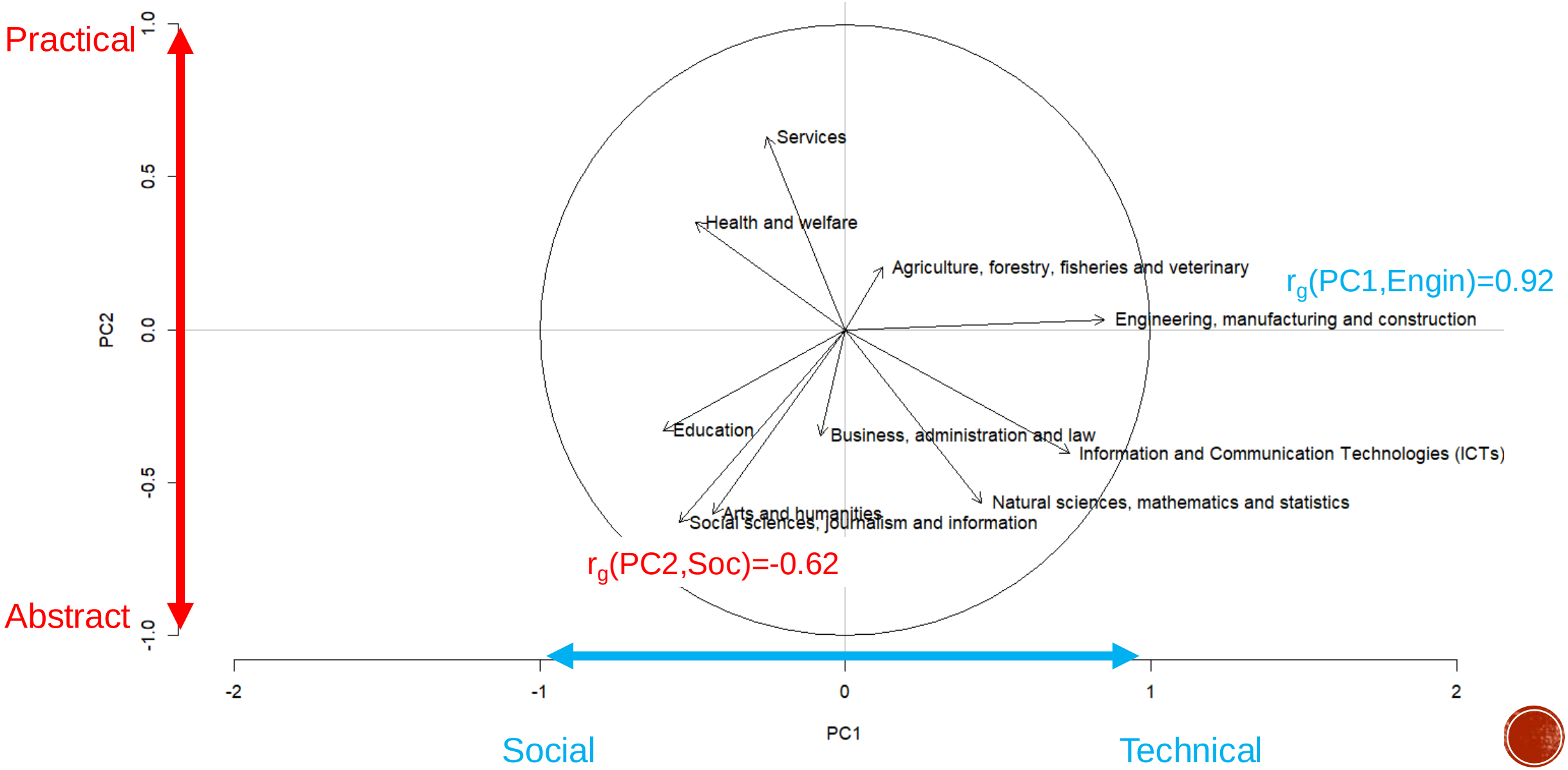


Genetic clustering among field specialisations

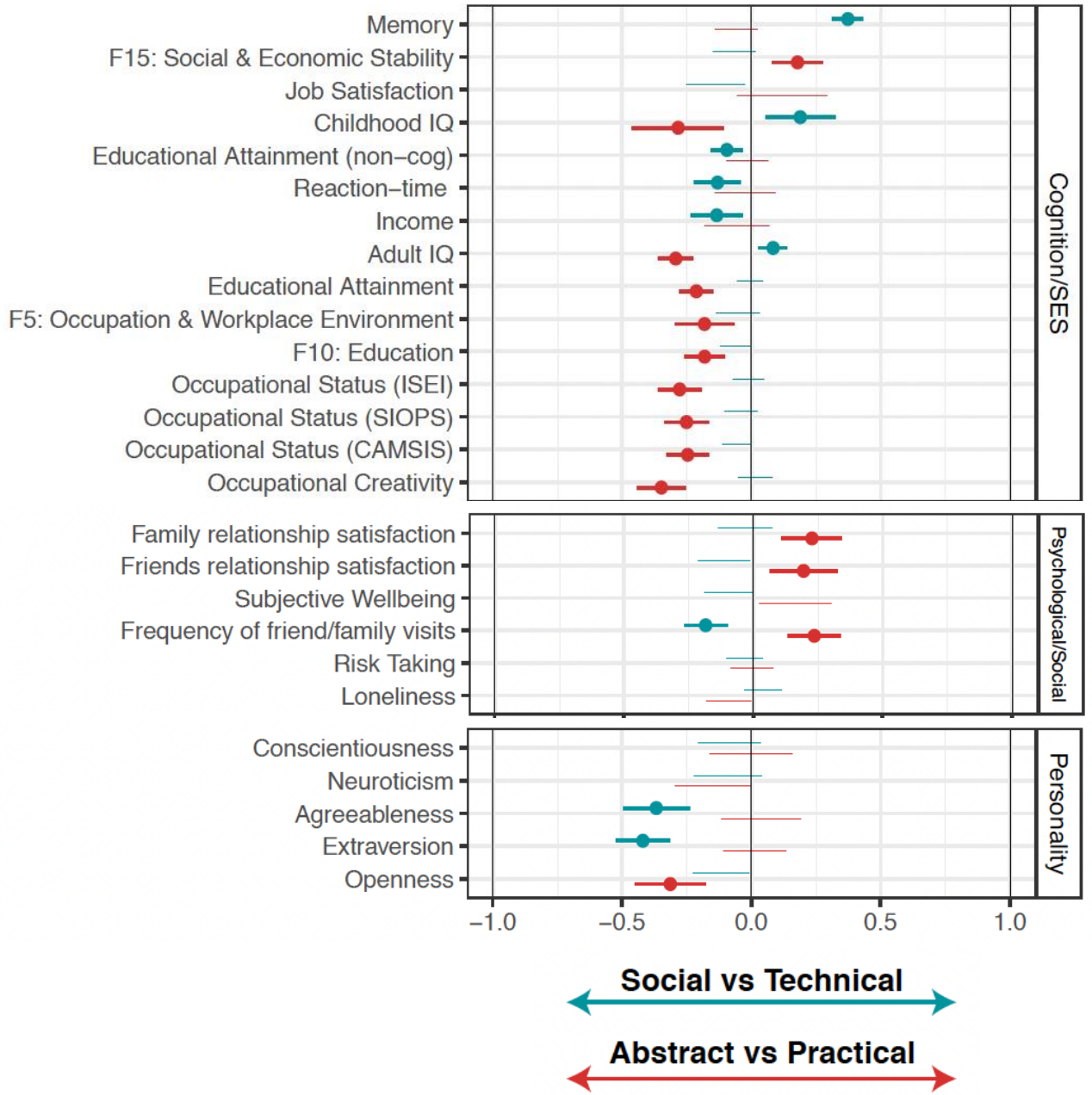


Methods:
LD score regression based on EA-adjusted GWAS summary statistics

2 principal genetic components describing sorting into fields



Phenome-wide genetic correlations with field components



Summary

1. Background on gene-environment interplay research in education
   - Key theories: **active, evocative and passive gene-environment correlation**
   - Key developments in the field: **from family-based methods, to population-wide genomic methods, to within-family genomics**

Summary

2. Using genetics to understand:

- Parental effects on offspring education: genetic tools for **causal inference**; identifying novel **latent** effects
- Horizontal educational stratification: genetic insights on **underlying structures**; expand the scope to **phenome-wide patterns**

- Other fruitful areas of social science genomics:
  - Gene-environment interaction studies to highlight how individuals respond differently to interventions (Paul)
  - Gene-environment correlation studies to highlight how individuals select and get affected by partners and friends (Giorgia)
  - **Social scientists are encouraged to incorporate these methods and contribute useful insights!**

THANKS FOR YOUR ATTENTION!

SCAN ME

Suggestions welcome!
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