CLOSER Conference

Education 1
Chair: Alison Park

  Alice Sullivan

- Examining the genetic influences on educational attainment and the validity of value-added measures of progress in educational research
  Tim Morris

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Password: BLgueST23

Alice Sullivan, Vanessa Moulton, Emla Fitzsimons
Background

• Importance of language transmission in theories of social stratification in education (Bourdieu, Bernstein)

• Although there is evidence of fluid IQ gains over time (Flynn) there is little evidence on whether language skills are improving

• Are inequalities changing over time?
Aims

• Investigate the inter-generational change in vocabulary attainment in Britain using young people’s vocabulary test scores in MCS6 (age 14) and BCS70 (age 16).

• Changes in: distribution of cognitive attainment, socio-economic differentials, other factors (region, sex).

• Can cross cohort differences be explained by changes in: occupational and educational characteristics; family structure and parenting, reading behaviours.
### MCS Age 14: Word Activity

1. QUICK  
   - always
   - best
   - neat
   - sick
   - fast

2. TIDINGS  
   - steps
   - reason
   - jetty
   - mountains
   - news

3. CONCEAL  
   - advise
   - hide
   - gather
   - freeze
   - conciliate

4. UNIQUE  
   - several
   - matchless
   - simple
   - ancient
   - absurd

5. DUBIOUS  
   - tawny
   - obstinate
   - gloomy
   - muddy
   - doubtful

6. TRIVIAL  
   - trefoil
   - alluvial
   - trifling
   - eccentric
   - tawdry

7. ORTHODOX  
   - conventional
   - angular
   - bohemian
   - liturgical
   - amazing

8. PLAUSIBLE  
   - aggressive
   - humane
   - shallow
   - wde
   - credible

9. SIGNIFY  
   - deter
   - subscribe
   - avail
   - submit
   - denote

10. CONSPICUOUS  
    - plotting
    - gargantuan
    - suspicious
    - prominent
    - deserved

[Next Ten Words]
Distribution of YP vocabulary scores by cohort (All giving vocab score, age and date of test, and white British).

MCS sample aged from 162-182 months (13 yrs 6 months to 15 yrs 2 months)
Maternal education and child mean vocab

- NVQ4
- NVQ3
- NVQ2
- NVQ1
- None

MCS
BCS
Linear regression: vocabulary scores

- Standardised across cohorts
- Model 0: cohort
- Model 1: cohort + age
- Model 2: model 1+ sex, country, social class, education, home ownership
- Model 3: model 2+ breastfeeding, age of mother at birth, birthweight, single parent, position in the birth order
- Model 4: model 3+ read to at 5, reading at 10/11, library visits at 10/11, reading at 14/16.
Model 0: raw cohort difference
Model 1: cohort + age in months
Model 2: socio-economic and demographic controls
Model 3: 1+ other childhood circumstances

- Cohort (1970)
- Breast fed < 3 months (ref: none)
- Breast fed 3 months or more
- Birthweight 2.5kg or more (ref: <2.5kg)
- Single parent (ref: not)
- Mother's age at birth of CM
Model 4: model 3 + reading

- cohort (1970)
- Age 5 read to less frequently (Ref:...)
  - Age 5 read to often
- Age 10/11 reading sometimes (ref:...)
  - Age 10/11 reading often
- Age 16/14 reading < once a week (ref:...)
  - Age 16/14 reading once a week
  - Age 16/14 reading > once a week
- Age 10/11 visits library sometimes (ref:...)
  - Age 10/11 visits library often
Education x cohort

Predictive Margins of cohort2#m_degree_miss with 95% CIs
Class x cohort

Predictive Margins of cohort2#HH_NSSEC3 with 95% CIs

- Linear Prediction

- cohort2

- HH_NSSEC3=1
- HH_NSSEC3=2
- HH_NSSEC3=3
- HH_NSSEC3=4
Discussion

• Results are preliminary and issues in x-cohort comparison need more attention.
• Apparent lower scores for younger cohort
• Class/education inequalities appear reduced
• X-cohort difference is amplified when controlling for factors such as breastfeeding and maternal age
• X-cohort difference is somewhat explained by reading behaviour
Examining genetic influences of educational attainment and the validity of value-added measures of progress in educational research

Tim Morris, Neil Davies, Danny Dorling, George Davey Smith

MRC Integrative Epidemiology Unit, University of Bristol
Value added measures

• Used to rank UK schools and feed into school league tables (Leckie & Goldstein, 2016)

• Permits estimation of knowledge gained, or value added by a teacher/school (Taylor & Nguyen, 2006)

• Used and discussed extensively in educational research

• Designed to overcome issues of intake bias when using raw attainment (Goldstein & Thomas, 1996)
Intake bias
Intake bias

A*  A*  A*  A*

E    E    E    C  C  C
• Raw VA measures adjust only for prior attainment

• Regardless, should account for background confounders through their association with the baseline measure of attainment

• Contextual VA measures additionally adjust for 9 socioeconomic and demographic characteristics

• Contextual VA measures also modelled in a multilevel framework
Influences of EA

- Parental involvement
- Genetics
- Personality
• VA measures SHOULD control for any genetic influences on educational attainment, and therefore demonstrate zero heritability

• But... Previous study estimated heritability at 52%! (Haworth et al, 2011)

• Findings seemed to be missed (ignored?) by educational researchers, but represents a potential problem with VA

• Our aim: to estimate heritability in VA scores built from rich point score data
• Data from the Avon Longitudinal Study of Parents and Children (ALSPAC)

• Recruited in 1991 & 1992

• Representative of UK population

• 14,775 children in full sample

• 7,988 children with data on 1+ outcome measure and genetic data

• Data linked to the UK National Pupil Database (NPD)
Outcomes

Educational lifecourse

Age 11
(Key Stage 2)

Age 14
(Key Stage 3)

Age 16
(Key Stage 4)
Educational lifecourse

Age 11 (Key Stage 2)

KS 2-3 VA

Age 14 (Key Stage 3)

KS 3-4 VA

Age 16 (Key Stage 4)

KS 2-4 VA
How do we measure genetics?
Analyses

• We use genome-wide complex trait analysis (GCTA) to estimate the heritability of EA and VA measures

• GCTA uses measured SNP level variation to compare genetic and phenotypic similarity between all pairs of unrelated individuals

• Where genetically similar pairs are more phenotypically similar than genetically dissimilar pairs then heritability estimates are higher

• The proportion of total variance in EA/VA that can be attributed to common genetic variation tells us the heritability
Results: heritability of attainment

- First step was to estimate heritability of educational attainment:

- Fairly consistent with prior findings (Branigan et al., 2013)
Results: heritability of VA

- Second step was to estimate heritability of VA:
• Third step was to estimate heritability of teacher assessed VA:
Conclusions

• Mixed evidence that VA measures control for genetic influences on educational attainment

• Raw VA measures have lower heritability than contextual VA measures

• May be due to measurement error, which supports high heritability of teacher assessed VA

• Demonstrates the use of genetic data to social scientists and social science research questions
Thank you for your attention

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University of Bristol


• We run a series of univariate analyses as follows:
  \[ y = X\beta + g + \epsilon \]

• where \( y \) is the heritability of a phenotype, \( X \) is a series of covariates, \( g \) is a normally distributed random effect with variance \( \sigma_g^2 \), and \( \epsilon \) is residual error with variance \( \sigma_\epsilon^2 \)

• The proportion of total phenotypic variance (genetic variance plus residual variance) that can be attributed to common genetic variation is the heritability of the trait:
  \[ \frac{\sigma_g^2}{\sigma_g^2 + \sigma_\epsilon^2} \]
### Table

<table>
<thead>
<tr>
<th>KS</th>
<th>n</th>
<th>mean</th>
<th>SD</th>
<th>Minimum</th>
<th>Maximum</th>
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<tbody>
<tr>
<td>KS2</td>
<td>6,070</td>
<td>806.875</td>
<td>194.138</td>
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<td>39.894</td>
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### Charts

1. **KS2 average point score (using fine grading) for contextual value added.**

2. **KS3 average point score (using fine grading) for contextual value added.**

3. **Average GCSE and equivalent point score per entry.**
### Results from population stratification adjusted univariate analyses of attainment

<table>
<thead>
<tr>
<th></th>
<th>KS2 points</th>
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<th>KS3 points</th>
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<tr>
<td></td>
<td></td>
<td>Estimate  SE</td>
<td>Variance  SE</td>
<td>Variance  SE</td>
<td>Variance  SE</td>
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<tr>
<td><strong>Genetic variance V(G)</strong></td>
<td></td>
<td>0.452  0.057</td>
<td>0.553  0.070</td>
<td>0.586  0.054</td>
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<tr>
<td><strong>Residual variance</strong></td>
<td></td>
<td>0.504  0.054</td>
<td>0.407  0.067</td>
<td>0.373  0.050</td>
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<tr>
<td><strong>Phenotypic variance V(P)</strong></td>
<td></td>
<td>0.956  0.017</td>
<td>0.960  0.020</td>
<td>0.959  0.017</td>
<td></td>
<td></td>
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<tr>
<td><strong>Heritability (ratio of V(G) to V(P))</strong></td>
<td></td>
<td>0.473  0.058</td>
<td>0.576  0.070</td>
<td>0.611  0.053</td>
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<tr>
<td><strong>Log Likelihood</strong></td>
<td></td>
<td>-2884.42</td>
<td>-2333.41</td>
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<tr>
<td></td>
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<td>-2920.09</td>
<td>-2368.02</td>
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<tr>
<td><strong>Likelihood ratio test</strong></td>
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<td>71.336</td>
<td>69.226</td>
<td>142.069</td>
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<tr>
<td><strong>p value</strong></td>
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<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
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<tr>
<td><strong>Sample size</strong></td>
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<td>6132</td>
<td>4960</td>
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Results from population stratification adjusted univariate analyses of VA measures

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<tr>
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<th>KS 2-3 value-added</th>
<th>KS 2-4 value-added</th>
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<tbody>
<tr>
<td></td>
<td>Estimate</td>
<td>SE</td>
<td>Variance</td>
</tr>
<tr>
<td>Genetic variance V(G)</td>
<td>&lt;0.001</td>
<td>0.064</td>
<td>0.071</td>
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<tr>
<td>Residual variance</td>
<td>0.931</td>
<td>0.067</td>
<td>0.835</td>
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<tr>
<td>Phenotypic variance V(P)</td>
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<td>Heritability (ratio of V(G) to V(P))</td>
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<tr>
<td>Log Likelihood</td>
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Results from population stratification adjusted univariate analyses of CVA measures

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<th>KS 2-4 contextual value-added</th>
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<td>Estimate</td>
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<tr>
<td>Genetic variance V(G)</td>
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<tr>
<td>Residual variance</td>
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<td>Phenotypic variance V(P)</td>
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Results from population stratification adjusted univariate analyses of teacher assessed VA measures

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<td>Residual variance</td>
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<td>Phenotypic variance V(P)</td>
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