School, neighbourhood and family contributions to pupils’ progress

Jon Rasbash, George Leckie, Rebecca Pillinger and Jenny Jenkins
1. Partitioning variation in progress
### What do we already know?

<table>
<thead>
<tr>
<th>Response Predictors</th>
<th>①</th>
<th>②</th>
<th>③</th>
<th>④</th>
<th>⑤</th>
<th>⑥</th>
<th>⑦</th>
<th>⑧</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Prog</td>
<td>Prog</td>
<td>Prog</td>
<td>Att</td>
<td>Att</td>
<td>Prog</td>
<td>Att</td>
<td>Prog</td>
</tr>
<tr>
<td>LEA Neighbhd</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>Secondary Primary</td>
<td>5—20</td>
<td>20</td>
<td>4</td>
<td>14</td>
<td>5</td>
<td>1</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Cohort</td>
<td>5</td>
<td>22</td>
<td>fixed</td>
<td>7</td>
<td>1</td>
<td>20</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Pupil</td>
<td>80—95</td>
<td>93</td>
<td>73</td>
<td>80</td>
<td>96</td>
<td>79</td>
<td>98</td>
<td>75</td>
</tr>
<tr>
<td>MZ twins</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DZ twins</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full sibs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. Typical school effectiveness studies, e.g. Goldstein et al. (2007) (primary schools) and Leckie (2008) (secondary schools)

2. Yang & Woodhouse (2001), progress from GCSE to A-level

3. Fielding et al. (2006)

4. Garner & Raudenbush (1991); predictors include family background, neighbourhood social deprivation and school fixed effects


7. Leckie (2009)

8. Duncan et al. (2001); US data; response is Peabody Picture Vocabulary Test
## What do we already know?

<table>
<thead>
<tr>
<th>Response Predictors</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Prog</td>
<td>Prog</td>
<td>Prog</td>
<td>Att</td>
<td>Prog</td>
<td>Prog</td>
<td>Att</td>
<td>Prog</td>
</tr>
<tr>
<td>LEA Neighbhd</td>
<td>0.2</td>
<td>3</td>
<td>20</td>
<td>14</td>
<td>5</td>
<td>4</td>
<td>1</td>
<td>0.20</td>
</tr>
<tr>
<td>Secondary Primary</td>
<td>5—20</td>
<td>5</td>
<td>22</td>
<td>fixed</td>
<td>7</td>
<td>1</td>
<td>20</td>
<td>23</td>
</tr>
<tr>
<td>Cohort</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.21</td>
</tr>
<tr>
<td>Pupil</td>
<td>80—95</td>
<td>93</td>
<td>73</td>
<td>80</td>
<td>79</td>
<td>75</td>
<td>70</td>
<td>88</td>
</tr>
<tr>
<td>MZ twins</td>
<td></td>
<td></td>
<td></td>
<td>73</td>
<td>96</td>
<td>79</td>
<td>88</td>
<td>0.78</td>
</tr>
<tr>
<td>DZ twins</td>
<td></td>
<td></td>
<td></td>
<td>73</td>
<td>96</td>
<td>79</td>
<td>88</td>
<td>0.64</td>
</tr>
<tr>
<td>Full sibs</td>
<td></td>
<td></td>
<td></td>
<td>73</td>
<td>96</td>
<td>79</td>
<td>88</td>
<td>0.51</td>
</tr>
</tbody>
</table>

1. Typical school effectiveness studies, e.g. Goldstein et al. (2007) (primary schools) and Leckie (2008) (secondary schools)
2. Yang & Woodhouse (2001), progress from GCSE to A-level
3. Fielding et al. (2006)
4. Garner & Raudenbush (1991); predictors include family background, neighbourhood social deprivation and school fixed effects
7. Leckie (2009)
8. Duncan et al. (2001); US data; response is Peabody Picture Vocabulary Test
### What do we already know?

<table>
<thead>
<tr>
<th>Response Predictors</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Prog</td>
<td>Prog</td>
<td>Prog</td>
<td>Att</td>
<td>Att</td>
<td>Prog</td>
<td>Att</td>
<td>Prog</td>
</tr>
<tr>
<td>LEA</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Neighbhd</td>
<td>0.2</td>
<td>3</td>
<td>2</td>
<td>20</td>
<td>4</td>
<td>14</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Secondary Primary</td>
<td>5—20</td>
<td>5</td>
<td>22</td>
<td>fixed</td>
<td>7</td>
<td>1</td>
<td>20</td>
<td>23</td>
</tr>
<tr>
<td>Primary Cohort</td>
<td>5—20</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pupil</td>
<td>80—95</td>
<td>93</td>
<td>73</td>
<td>80</td>
<td>96</td>
<td>79</td>
<td>98</td>
<td>75</td>
</tr>
<tr>
<td>MZ twins</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DZ twins</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full sibs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. Typical school effectiveness studies, e.g. Goldstein et al. (2007) (primary schools) and Leckie (2008) (secondary schools)
2. Yang & Woodhouse (2001), progress from GCSE to A-level
3. Fielding et al. (2006)
4. Garner & Raudenbush (1991); predictors include family background, neighbourhood social deprivation and school fixed effects
7. Leckie (2009)
8. Duncan et al. (2001); US data; response is Peabody Picture Vocabulary Test
## What do we already know?

<table>
<thead>
<tr>
<th>Response Predictors</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Prog</td>
<td>Prog</td>
<td>Prog</td>
<td>Att</td>
<td>Att</td>
<td>Prog</td>
<td>Att</td>
<td>Prog</td>
</tr>
<tr>
<td>LEA Neighbhd</td>
<td>0.2</td>
<td>3</td>
<td>2</td>
<td>20</td>
<td>4</td>
<td>14</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Secondary Primary</td>
<td>5—20</td>
<td>5</td>
<td>22</td>
<td>fixed</td>
<td>7</td>
<td>1</td>
<td>20</td>
<td>23</td>
</tr>
<tr>
<td>Cohort</td>
<td>5—20</td>
<td>3</td>
<td></td>
<td></td>
<td>75</td>
<td>70</td>
<td>88</td>
<td></td>
</tr>
<tr>
<td>Pupil</td>
<td>80—95</td>
<td>93</td>
<td>73</td>
<td>80</td>
<td>96</td>
<td>79</td>
<td>98</td>
<td>75</td>
</tr>
<tr>
<td>MZ twins DZ twins</td>
<td>80—95</td>
<td>93</td>
<td>73</td>
<td>80</td>
<td>96</td>
<td>79</td>
<td>98</td>
<td>75</td>
</tr>
<tr>
<td>Full sibs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. Typical school effectiveness studies, e.g. Goldstein et al. (2007) (primary schools) and Leckie (2008) (secondary schools)
2. Yang & Woodhouse (2001), progress from GCSE to A-level
3. Fielding et al. (2006)
4. Garner & Raudenbush (1991); predictors include family background, neighbourhood social deprivation and school fixed effects
7. Leckie (2009)
8. Duncan et al. (2001); US data; response is Peabody Picture Vocabulary Test
Typical school effectiveness studies, e.g. Goldstein et al. (2007) (primary schools) and Leckie (2008) (secondary schools)

Yang & Woodhouse (2001), progress from GCSE to A-level

Fielding et al. (2006)

Garner & Raudenbush (1991); predictors include family background, neighbourhood social deprivation and school fixed effects

Raudenbush (1993); reanalysis of Garner & Raudenbush (1991)

Leckie (2009)

Leckie (2009)

Duncan et al. (2001); US data; response is Peabody Picture Vocabulary Test
## What do we already know?

<table>
<thead>
<tr>
<th>Response Predictors</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEA Neighbhd</td>
<td>✅</td>
<td>✏️</td>
<td>✏️</td>
<td>✏️</td>
<td>✏️</td>
<td>✏️</td>
<td>✏️</td>
<td>✏️</td>
</tr>
<tr>
<td>Secondary Primary</td>
<td>5️⃣−️⃣2️⃣0️⃣</td>
<td>5️⃣</td>
<td>2️⃣2️⃣</td>
<td>✏️</td>
<td>✏️</td>
<td>✏️</td>
<td>✏️</td>
<td>✏️</td>
</tr>
<tr>
<td>Cohort</td>
<td>3️⃣</td>
<td>✏️</td>
<td>✏️</td>
<td>✏️</td>
<td>✏️</td>
<td>✏️</td>
<td>✏️</td>
<td>✏️</td>
</tr>
<tr>
<td>Pupil</td>
<td>8️⃣0️⃣−️⃣9️⃣5️⃣</td>
<td>8️⃣0️⃣−️⃣9️⃣5️⃣</td>
<td>9️⃣3️⃣</td>
<td>7️⃣3️⃣</td>
<td>8️⃣0️⃣</td>
<td>9️⃣6️⃣</td>
<td>7️⃣9️⃣</td>
<td>9️⃣8️⃣</td>
</tr>
<tr>
<td>MZ twins</td>
<td>✏️</td>
<td>✏️</td>
<td>✏️</td>
<td>✏️</td>
<td>✏️</td>
<td>✏️</td>
<td>✏️</td>
<td>✏️</td>
</tr>
<tr>
<td>DZ twins</td>
<td>✏️</td>
<td>✏️</td>
<td>✏️</td>
<td>✏️</td>
<td>✏️</td>
<td>✏️</td>
<td>✏️</td>
<td>✏️</td>
</tr>
<tr>
<td>Full sibs</td>
<td>✏️</td>
<td>✏️</td>
<td>✏️</td>
<td>✏️</td>
<td>✏️</td>
<td>✏️</td>
<td>✏️</td>
<td>✏️</td>
</tr>
</tbody>
</table>

1️⃣ Typical school effectiveness studies, e.g. Goldstein et al. (2007) (primary schools) and Leckie (2008) (secondary schools)

2️⃣ Yang & Woodhouse (2001), progress from GCSE to A-level

3️⃣ Fielding et al. (2006)

4️⃣ Garner & Raudenbush (1991); predictors include family background, neighbourhood social deprivation and school fixed effects

5️⃣ Raudenbush (1993); reanalysis of Garner & Raudenbush (1991)

6️⃣ Leckie (2009)

7️⃣ Leckie (2009)

8️⃣ Duncan et al. (2001); US data; response is Peabody Picture Vocabulary Test
What do we already know?

<table>
<thead>
<tr>
<th>Response Predictors</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Prog</td>
<td>Prog</td>
<td>Prog</td>
<td>Att</td>
<td>Att</td>
<td>Prog</td>
<td>Att</td>
<td>Att</td>
</tr>
<tr>
<td>LEA Neighbhd</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Secondary Primary</td>
<td>5—20</td>
<td>5</td>
<td>22</td>
<td>fixed</td>
<td>7</td>
<td>1</td>
<td>20</td>
<td>23</td>
</tr>
<tr>
<td>Cohort</td>
<td>5—20</td>
<td>5</td>
<td>22</td>
<td>fixed</td>
<td>7</td>
<td>1</td>
<td>20</td>
<td>23</td>
</tr>
<tr>
<td>Pupil</td>
<td>5—20</td>
<td>5</td>
<td>22</td>
<td>fixed</td>
<td>7</td>
<td>1</td>
<td>20</td>
<td>23</td>
</tr>
</tbody>
</table>

1. Typical school effectiveness studies, e.g. Goldstein et al. (2007) (primary schools) and Leckie (2008) (secondary schools)
2. Yang & Woodhouse (2001), progress from GCSE to A-level
3. Fielding et al. (2006)
4. Garner & Raudenbush (1991); predictors include family background, neighbourhood social deprivation and school fixed effects
7. Leckie (2009)
8. Duncan et al. (2001); US data; response is Peabody Picture Vocabulary Test
What do we already know?

<table>
<thead>
<tr>
<th>Response Predictors</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Att N</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| LEA Neighbhd        |   |   |   |   |   |   |   |   |   |    |    |    |
| Secondary Primary   |   |   |   |   |   |   |   |   |   |    |    |    |
| Cohort              |   |   |   |   |   |   |   |   |   |    |    |    |
| Non-shared envt     | 0 | 43| 10| 10| 6 | 11| 24| 29| 14| 9  | 23 | 24 |
| Genetic             | 38| 21| 17| 53| 28| 53| 60| 36| 67| 67 | 68 | 49 |
| Shared envt         | 62| 36| 73| 37| 66| 36| 16| 35| 19| 24 | 9  | 27 |

1. Cardon et al. (1990); reading recognition
2. Brooks et al. (1990); spelling
3. Thompson et al. (1991); maths
4. Thompson et al. (1993); composite of WRAT-R and MAT
5. Petrill & Thompson (1993); MAT
6. Petrill & Thompson (1994); MAT
7. Van den Oord & Rowe (1997); PIAT
8. Cleveland et al. (2000); composite of PPVT and PIATS
9. Wainwright et al. (2005); QCST, Australian data
10. Friend et al. (2007); spelling production (WRAT)
11. Haworth et al. (2007); maths, UK data
12. Haworth et al. (2008); science, UK data
School effectiveness

- Models usually have pupils within schools (2 levels)

Developmental Psychology

- Researchers recognise that these models partition into shared environment and non-shared environment
- What is the shared environment?
- In other words, how much of the shared environment is family, school and area?
Previous studies

School effectiveness

- Models usually have pupils within schools (2 levels)
- There have been studies that also included area or primary school

Developmental Psychology

- Models usually have children within families
- Researchers recognise that really these models partition into shared environment and non-shared environment
- What is the shared environment?
- In other words, How much of the shared environment is family, school and area?
**School effectiveness**

- Models usually have pupils within schools (2 levels)
- There have been studies that also included area or primary school
- But no studies have included family

**Developmental Psychology**

- Models usually have children within families
- Researchers recognise that really these models partition into shared environment and non-shared environment
- What is the shared environment?
  - In other words, How much of the shared environment is family, school and area?
Previous studies

School effectiveness

- Models usually have pupils within schools (2 levels)
- There have been studies that also included area or primary school
- But no studies have included family
- The largest component of variation in these models is the pupil level

Developmental Psychology

Models usually have children within families. Researchers recognise that really these models partition into shared environment and non-shared environment. What is the shared environment? In other words, how much of the shared environment is family, school and area?
School effectiveness
- Models usually have pupils within schools (2 levels)
- There have been studies that also included area or primary school
- But no studies have included family
- The largest component of variation in these models is the pupil level
- How much of that is really family level?

Developmental Psychology
- Models usually have children within families
- Researchers recognise that really these models partition into shared environment and non-shared environment
- What is the shared environment?
- In other words, how much of the shared environment is family, school and area?
Previous studies

School effectiveness
- Models usually have pupils within schools (2 levels)
- There have been studies that also included area or primary school
- But no studies have included family
- The largest component of variation in these models is the pupil level
- How much of that is really family level?

Developmental Psychology
- Models usually have children within families
### Previous studies

#### School effectiveness
- Models usually have pupils within schools (2 levels)
- There have been studies that also included area or primary school
- But no studies have included family
- The largest component of variation in these models is the pupil level
- How much of that is really family level?

#### Developmental Psychology
- Models usually have children within families
- Researchers recognise that really these models partition into shared environment and non-shared environment
School effectiveness
- Models usually have pupils within schools (2 levels)
- There have been studies that also included area or primary school
- But no studies have included family
- The largest component of variation in these models is the pupil level
- How much of that is really family level?

Developmental Psychology
- Models usually have children within families
- Researchers recognise that really these models partition into shared environment and non-shared environment
- What is the shared environment?
Previous studies

School effectiveness
- Models usually have pupils within schools (2 levels)
- There have been studies that also included area or primary school
- But no studies have included family
- The largest component of variation in these models is the pupil level
- How much of that is really family level?

Developmental Psychology
- Models usually have children within families
- Researchers recognise that really these models partition into shared environment and non-shared environment
- What is the shared environment?
- In other words, How much of the shared environment is family, school and area?
School effectiveness

- Models usually have pupils within schools (2 levels)
- There have been studies that also included area or primary school
- But no studies have included family
- The largest component of variation in these models is the pupil level
- How much of that is really family level?

Classification diagram

- school
- pupil

$\begin{align*}
\text{Model: } & u_j \sim N(0, \sigma_u^2), j = 1, \ldots, n_j \\
& e_{ij} \sim N(0, \sigma_e^2), j = 1, \ldots, J(B)
\end{align*}$
School effectiveness

- Models usually have pupils within schools (2 levels)
- There have been studies that also included area or primary school
- But no studies have included family
- The largest component of variation in these models is the pupil level
- How much of that is really family level?

Classification diagram
School effectiveness

- Models usually have pupils within schools (2 levels)
- There have been studies that also included area or primary school
- But no studies have included family
- The largest component of variation in these models is the pupil level
- How much of that is really family level?

Classification diagram

- LEA
- School
- Cohort
- Pupil
Previous studies

School effectiveness
- Models usually have pupils within schools (2 levels)
- There have been studies that also included area or primary school
- But no studies have included family
- The largest component of variation in these models is the pupil level
- How much of that is really family level?

Classification diagram

- school
- area
- pupil

\[ u_j \sim N(0, \sigma^2_u), \quad i = 1, \ldots, n_j \]
\[ e_{ij} \sim N(0, \sigma^2_e), \quad j = 1, \ldots, J(B) \]
Previous studies

School effectiveness
- Models usually have pupils within schools (2 levels)
- There have been studies that also included area or primary school
- But no studies have included family
- The largest component of variation in these models is the pupil level
- How much of that is really family level?

Classification diagram

- LEA 1
- LEA 2
- school
- area
- pupil

\[ \begin{align*}
  u_j & \sim N(0, \sigma_u^2), i = 1, \ldots, n_j \\
  e_{ij} & \sim N(0, \sigma_e^2), j = 1, \ldots, J(B) 
\end{align*} \]
School effectiveness

- Models usually have pupils within schools (2 levels)
- There have been studies that also included area or primary school
- But no studies have included family
- The largest component of variation in these models is the pupil level
- How much of that is really family level?

Classification diagram:

- secondary
- primary
- pupil
Previous studies

School effectiveness
- Models usually have pupils within schools (2 levels)
- There have been studies that also included area or primary school
- But no studies have included family
- The largest component of variation in these models is the pupil level
- How much of that is really family level?

Classification diagram
- secondary
- area
- primary
- pupil
**Previous studies**

**School effectiveness**
- Models usually have pupils within schools (2 levels)
- There have been studies that also included area or primary school
- But no studies have included family
- The largest component of variation in these models is the pupil level
- How much of that is really family level?

**Classification diagram**

![](image)

**Model**

\[ y_{ij} = \alpha + \beta x_{ij} + u_j + e_{ij}, \]

\[ u_j \sim N \left(0, \sigma_u^2 \right), \quad i = 1, \ldots, n_j \]

\[ e_{ij} \sim N \left(0, \sigma_e^2 \right), \quad j = 1, \ldots, J \]

(B)
Previous studies

School effectiveness
- Models usually have pupils within schools (2 levels)
- There have been studies that also included area or primary school
- But no studies have included family
- The largest component of variation in these models is the pupil level
- How much of that is really family level?

Classification diagram

Model
\[ \text{GCSE}_{ij} = \alpha + \beta \text{pretest}_{ij} + u_j + e_{ij}, \]
\[ u_j \sim N(0, \sigma_u^2), \quad i = 1, \ldots, n_j \]
\[ e_{ij} \sim N(0, \sigma_e^2), \quad j = 1, \ldots, J \]
Previous studies

School effectiveness
- Models usually have pupils within schools (2 levels)
- There have been studies that also included area or primary school
- But no studies have included family
- The largest component of variation in these models is the pupil level
- How much of that is really family level?

Classification diagram

Model

\[ GCSE_{ij} = \alpha + \beta_1 \text{pretest}_{ij} + \beta_2 x_{ij} + u_j + e_{ij}, \]

\[ u_j \sim N(0, \sigma_u^2), \quad i = 1, \ldots, n_j \]

\[ e_{ij} \sim N(0, \sigma_e^2), \quad j = 1, \ldots, J \]
Previous studies

Classification diagram

- family
- pupil

Developmental Psychology

- Models usually have children within families.
- Researchers recognise that really these models partition into shared environment and non-shared environment.
- What is the shared environment?
- In other words, How much of the shared environment is family, school and area?
Previous studies

Classification diagram

![Classification diagram with family and pupil nodes]

Model

\[ y_{ij} = \alpha + u_j + e_{ij} + g_{ij} \]

\[ u_j \sim N(0, \sigma_u^2) \]

\[ e_{ij} \sim N(0, \sigma_e^2) \]

\[ g_{ij} \sim N(0, \sigma_g^2) \]

\[ \text{Cov}(g_{i1j}, g_{i2j}) = r_{(i1j, i2j)} \sigma_g^2 \]

Developmental Psychology

- Models usually have children within families
- Researchers recognise that really these models partition into shared environment and non-shared environment
- What is the shared environment?
- In other words, How much of the shared environment is family, school and area?
Previous studies

Classification diagram

```
family
  
pupil
```

Model

\[ y_{ij} = \alpha + d_j u_{1j} + d_j e_{1ij} + (1 - d_j) e_{2ij} \]

\[
\begin{align*}
  u_{1j} &\sim N \left(0, \sigma^2_u\right) \\
  \begin{bmatrix} e_{1ij} \\ e_{2ij} \end{bmatrix} &\sim N \left(\begin{bmatrix} 0 \\ 0 \end{bmatrix}, \begin{bmatrix} \sigma^2_{e1} & 0 \\ 0 & \sigma^2_{e2} \end{bmatrix}\right)
\end{align*}
\]

Developmental Psychology

- Models usually have children within families
- Researchers recognise that really these models partition into shared environment and non-shared environment
- What is the shared environment?
- In other words, How much of the shared environment is family, school and area?
Previous studies

Classification diagram

Model

\[ GCSE_{ij} = \alpha + u_{1j}^{\text{twin}} + e_{1ij}^{\text{twin}} + e_{2ij}^{\text{nontwin}} \]

\[ u_{1j} \sim N(0, \sigma_{u}^2) \]

\[
\begin{bmatrix}
  e_{1ij} \\
  e_{2ij}
\end{bmatrix} \sim N\left( \begin{bmatrix} 0 \\ 0 \end{bmatrix}, \begin{bmatrix} \sigma_{e1}^2 & 0 \\ 0 & \sigma_{e2}^2 \end{bmatrix} \right)
\]

Developmental Psychology

- Models usually have children within families.
- Researchers recognise that really these models partition into shared environment and non-shared environment.
- What is the shared environment?
- In other words, How much of the shared environment is family, school and area?
Previous studies

Classification diagram

Model

\[ GCSE_{ij} = \alpha + \beta_1 pretest_{ij} + \beta_2 twin_{ij} + \beta_3 twin_j \cdot pretest_{ij} + u_{1j} twin_j + e_{1ij} twin_j + e_{2ij} nontwin_j \]

\[ u_{1j} \sim N (0, \sigma_u^2) , \]

\[ \begin{bmatrix} e_{1ij} \\ e_{2ij} \end{bmatrix} \sim N \left( \begin{bmatrix} 0 \\ 0 \end{bmatrix} , \begin{bmatrix} \sigma_{e1}^2 \\ 0 & \sigma_{e2}^2 \end{bmatrix} \right) \]

Developmental Psychology

- Models usually have children within families
- Researchers recognise that really these models partition into shared environment and non-shared environment
- What is the shared environment?
- In other words, How much of the shared environment is family, school and area?
Our model

\[ y_i = \alpha + \beta x_i + u(6) \]

\[ LEA(i) + u(5) \text{sec}(i) + u(4) \text{nbhd}(i) + u(3) \text{pri}(i) + u(2) \text{fam}(i) \]

\[ dfam(i) + e_1 i \text{id}_{dfam}(i) + e_2 i (1 - dfam(i)) \]

\[ u(6) \text{LEA}(i) \sim N(0, \sigma^2_{u(6)}) \]

\[ u(3) \text{pri}(i) \sim N(0, \sigma^2_{u(3)}) \]

\[ u(2) \text{fam}(i) \sim N(0, \sigma^2_{u(2)}) \]

\[ [e_1 i e_2 i] \sim N(0, \begin{bmatrix} \sigma^2_{e1} & 0 \\ 0 & \sigma^2_{e2} \end{bmatrix}) \]

Classification diagram
Our model

\[ y_i = \alpha + \beta x_i + u \] (6)

LEA \((i)\) + u (5) sec \((i)\) + u (4) nbhd \((i)\) + u (3) pri \((i)\) + u (2) fam \((i)\) dfam \((i)\) + e1 \([\text{id fam} (i)]\) + e2 \([\text{1-dfam} (i)]\)

Classification diagram

- LEA
- neighbhd
- secondary
- primary
- pupil, family
Our model

Model

\[ y_i = \alpha + \beta x_i + u\text{LEA}(i) + u\text{sec}(i) + u\text{nbhd}(i) + u\text{pri}(i) \]
\[ + u\text{fam}(i) d\text{fam}(i) + e_1 d\text{fam}(i) + e_2 (1 - d\text{fam}(i)) \]

\[ u\text{LEA}(i) \sim N\left(0, \sigma^2_u(6)\right) \]
\[ \vdots \]
\[ u\text{pri}(i) \sim N\left(0, \sigma^2_u(3)\right) \]
\[ u\text{fam}(i) \sim N\left(0, \sigma^2_u(2)\right) \]

\[ \begin{bmatrix} e_1 \nc\nc\nc\n e_2 \end{bmatrix} \sim N\left(0, \begin{bmatrix} \sigma^2_{e1} & 0 \\ 0 & \sigma^2_{e2} \end{bmatrix}\right) \] (C)

Classification diagram
Our model

Model

\[ \text{GCSE}_i = \alpha + \beta_1 \text{pretest}_i + \beta_2 \text{twin}_i + \beta_3 \text{pretest} \cdot \text{twin}_i \]

\[ + u_{\text{LEA}(i)}^{(6)} + u_{\text{sec}(i)}^{(5)} + u_{\text{nbhd}(i)}^{(4)} + u_{\text{pri}(i)}^{(3)} \]

\[ + u_{\text{fam}(i)}^{(2)} \text{twin}_{\text{fam}(i)} + e_{1i} \text{twin}_{\text{fam}(i)} + e_{2i} \text{nontwin}_{\text{fam}(i)} \]

\[ u_{\text{LEA}(i)}^{(6)} \sim N \left(0, \sigma^2_{u(6)} \right) \]

\[ \vdots \quad \vdots \]

\[ u_{\text{pri}(i)}^{(3)} \sim N \left(0, \sigma^2_{u(3)} \right) \]

\[ u_{\text{fam}(i)}^{(2)} \sim N \left(0, \sigma^2_{u(2)} \right) \]

\[ \begin{bmatrix} e_{1i} \\ e_{2i} \end{bmatrix} \sim N \left(0, \begin{bmatrix} \sigma^2_{e1} & \sigma^2_{e2} \\ 0 & \sigma^2_{e2} \end{bmatrix} \right) \]

(C)
Our data

Sample
All pupils in
- England
- state schools
- 2007 GCSE cohort
### Sample
- All pupils in
  - England
  - state schools
  - 2007 GCSE cohort

### Variables
- Test scores from the NPD
  - GCSE (our response) and key stage 2 (KS2)

All continuous variables have been standardized.
Our data

Sample
All pupils in
- England
- state schools
- 2007 GCSE cohort

Variables
- Test scores from the NPD
  - GCSE (our response) and key stage 2 (KS2)
- Background characteristics from PLASC
  - age
  - gender
  - ethnicity
  - FSM eligibility
  - SEN
  - EAL

All continuous variables have been standardized
Our data

Sample
All pupils in
- England
- state schools
- 2007 GCSE cohort

Variables
- Test scores from the NPD
  - GCSE (our response) and key stage 2 (KS2)
- Background characteristics from PLASC
  - age
  - gender
  - ethnicity
  - FSM eligibility
  - SEN
  - EAL
- ONS data on LSOAs
  - IDACI

All continuous variables have been standardized
Our data

Sample
All pupils in
- England
- state schools
- 2007 GCSE cohort

Levels
- The data records which
  - LEA
  - secondary school
  - primary school
  - area (LSOA)
each pupil belongs to

Variables
- Test scores from the NPD
  - GCSE (our response) and key stage 2 (KS2)
- Background characteristics from PLASC
  - age
  - gender
  - ethnicity
  - FSM eligibility
  - SEN
  - EAL
- ONS data on LSOAs
  - IDACI

All continuous variables have been standardized
Our data

Sample

All pupils in
- England
- state schools
- 2007 GCSE cohort

Levels

The data records which
- LEA
- secondary school
- primary school
- area (LSOA)
each pupil belongs to

But not which family

Variables

- Test scores from the NPD
  - GCSE (our response) and key stage 2 (KS2)
- Background characteristics from PLASC
  - age
  - gender
  - ethnicity
  - FSM eligibility
  - SEN
  - EAL
- ONS data on LSOAs
  - IDACI

All continuous variables have been standardized
Identifying twins

- We get the family level by identifying twin pairs
Our data

Identifying twins
- We get the family level by identifying twin pairs
- by matching on time invariant characteristics
  - date of birth
  - ethnicity
  - EAL

How successful is this?
11.54 twin births per 1000 maternities in 1990 & 1991
9.37 twin pairs per 1000 families in our matching
We may also have labelled some unrelated pupils as a 'twin pair'
Calculation suggests around 10% of 'twin pairs' will be coincidental matches

Size of dataset
- 551,220 pupils
- 30507 LSOAs
- 3099 secondaries
- 5116 twin pairs
- 14765 primaries
- 149 LEAs
Our data

Identifying twins

- We get the family level by identifying twin pairs
- by matching on time invariant characteristics
  - date of birth
  - ethnicity
  - EAL
- and pattern of time-varying characteristics
  - postcode sector
  - FSM eligibility

How successful is this?

- 11.54 twin births per 1000 maternities in 1990 & 1991
- 9.37 twin pairs per 1000 families in our matching

We may also have labelled some unrelated pupils as a 'twin pair'

Calculation suggests around 10% of 'twin pairs' will be coincidental matches

Size of dataset

- 551,220 pupils
- 30,507 LSOAs
- 30,992 secondaries
- 5,116 twin pairs
- 14,765 primaries
- 14,925 LEAs
Identifying twins

- We get the family level by identifying twin pairs
- by matching on time invariant characteristics
  - date of birth
  - ethnicity
  - EAL
- and pattern of time-varying characteristics
  - postcode sector
  - FSM eligibility

How successful is this?

- 11.54 twin births per 1000 maternities in 1990 & 1991
Identifying twins
- We get the family level by identifying twin pairs by matching on time invariant characteristics
  - date of birth
  - ethnicity
  - EAL
- and pattern of time-varying characteristics
  - postcode sector
  - FSM eligibility

How successful is this?
- 11.54 twin births per 1000 maternities in 1990 & 1991
- 9.37 twin pairs per 1000 families in our matching

We may also have labelled some unrelated pupils as a 'twin pair'.
Calculation suggests around 10% of 'twin pairs' will be coincidental matches.

Size of dataset:
- 551,220 pupils
- 30,507 LSOAs
- 3,099 secondaries
- 5,116 twin pairs
- 14,765 primaries
- 14,916 LEAs
Our data

Identifying twins
- We get the family level by identifying twin pairs
- by matching on time invariant characteristics
  - date of birth
  - ethnicity
  - EAL
- and pattern of time-varying characteristics
  - postcode sector
  - FSM eligibility

How successful is this?
- 11.54 twin births per 1000 maternities in 1990 & 1991
- 9.37 twin pairs per 1000 families in our matching
- We may also have labelled some unrelated pupils as a ‘twin pair’
Identifying twins

- We get the family level by identifying twin pairs by matching on time invariant characteristics.
  - date of birth
  - ethnicity
  - EAL
- and pattern of time-varying characteristics
  - postcode sector
  - FSM eligibility

How successful is this?

- 11.54 twin births per 1000 maternities in 1990 & 1991
- 9.37 twin pairs per 1000 families in our matching
- We may also have labelled some unrelated pupils as a ‘twin pair’
- Calculation suggests around 10% of ‘twin pairs’ will be coincidental matches
Our data

Identifying twins
- We get the family level by identifying twin pairs
- by matching on time invariant characteristics
  - date of birth
  - ethnicity
  - EAL
- and pattern of time-varying characteristics
  - postcode sector
  - FSM eligibility

How successful is this?
- 11.54 twin births per 1000 maternities in 1990 & 1991
- 9.37 twin pairs per 1000 families in our matching
- We may also have labelled some unrelated pupils as a ‘twin pair’
- Calculation suggests around 10% of ‘twin pairs’ will be coincidental matches

Size of dataset
- 551,220 pupils
- 5116 twin pairs
- 30507 LSOAs
- 14765 primaries
- 3099 secondaries
- 149 LEAs
### Results

Using MCMC; 450,500 iterations and a burn-in of 50,000

<table>
<thead>
<tr>
<th></th>
<th>Model A</th>
<th>Model B</th>
<th>Model C</th>
<th>Model D</th>
</tr>
</thead>
<tbody>
<tr>
<td>cons</td>
<td>-0.003 (0.001)</td>
<td>-0.003 (0.001)</td>
<td>0.001 (0.008)</td>
<td>-0.039 (0.007)</td>
</tr>
<tr>
<td>twin</td>
<td>0.177 (0.008)</td>
<td>0.179 (0.007)</td>
<td>0.162 (0.007)</td>
<td>0.154 (0.007)</td>
</tr>
<tr>
<td>pretest</td>
<td>0.730 (0.001)</td>
<td>0.729 (0.001)</td>
<td>0.701 (0.001)</td>
<td>0.641 (0.001)</td>
</tr>
<tr>
<td>pretest.twin</td>
<td>-0.040 (0.007)</td>
<td>0.000 (0.007)</td>
<td>-0.027 (0.006)</td>
<td>-0.020 (0.006)</td>
</tr>
<tr>
<td>female</td>
<td></td>
<td></td>
<td></td>
<td>0.184 (0.002)</td>
</tr>
<tr>
<td>Asian</td>
<td></td>
<td></td>
<td></td>
<td>0.429 (0.005)</td>
</tr>
<tr>
<td>Black</td>
<td></td>
<td></td>
<td></td>
<td>0.225 (0.006)</td>
</tr>
<tr>
<td>Chinese</td>
<td></td>
<td></td>
<td></td>
<td>0.556 (0.015)</td>
</tr>
<tr>
<td>Mixed</td>
<td></td>
<td></td>
<td></td>
<td>0.045 (0.005)</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
<td>0.403 (0.010)</td>
</tr>
<tr>
<td>FSM</td>
<td></td>
<td></td>
<td></td>
<td>-0.248 (0.003)</td>
</tr>
<tr>
<td>age</td>
<td></td>
<td></td>
<td></td>
<td>-0.012 (0.000)</td>
</tr>
<tr>
<td>SEN</td>
<td></td>
<td></td>
<td></td>
<td>-0.231 (0.003)</td>
</tr>
<tr>
<td>IDACI</td>
<td></td>
<td></td>
<td></td>
<td>-0.103 (0.001)</td>
</tr>
<tr>
<td>LEA</td>
<td></td>
<td></td>
<td>0.005 (0.001)</td>
<td>0.005 (0.001)</td>
</tr>
<tr>
<td>Secondary</td>
<td>0.065 (0.002)</td>
<td>0.043 (0.001)</td>
<td>0.035 (0.001)</td>
<td>0.035 (0.001)</td>
</tr>
<tr>
<td>Primary</td>
<td></td>
<td>0.035 (0.001)</td>
<td>0.025 (0.000)</td>
<td></td>
</tr>
<tr>
<td>LSOA</td>
<td></td>
<td>0.008 (0.000)</td>
<td>0.002 (0.000)</td>
<td></td>
</tr>
<tr>
<td>Family (twin)</td>
<td>0.238 (0.007)</td>
<td>0.168 (0.005)</td>
<td>0.157 (0.005)</td>
<td></td>
</tr>
<tr>
<td>Pupil (twin)</td>
<td>0.160 (0.003)</td>
<td>0.157 (0.003)</td>
<td>0.150 (0.003)</td>
<td></td>
</tr>
<tr>
<td>Pupil (non-twin)</td>
<td>0.468 (0.001)</td>
<td>0.402 (0.002)</td>
<td>0.383 (0.001)</td>
<td>0.357 (0.001)</td>
</tr>
</tbody>
</table>
### Results

<table>
<thead>
<tr>
<th></th>
<th>Model A</th>
<th>Model B</th>
<th>Model C</th>
<th>Model D</th>
</tr>
</thead>
<tbody>
<tr>
<td>cons</td>
<td>$-0.003 (0.001)$</td>
<td>$-0.003 (0.001)$</td>
<td>$0.001 (0.008)$</td>
<td>$-0.039 (0.007)$</td>
</tr>
<tr>
<td>twin</td>
<td>$0.177 (0.008)$</td>
<td>$0.179 (0.007)$</td>
<td>$0.162 (0.007)$</td>
<td>$0.154 (0.007)$</td>
</tr>
<tr>
<td>pretest</td>
<td>$0.730 (0.001)$</td>
<td>$0.729 (0.001)$</td>
<td>$0.701 (0.001)$</td>
<td>$0.641 (0.001)$</td>
</tr>
<tr>
<td>pretest.twin</td>
<td>$-0.040 (0.007)$</td>
<td>$0.000 (0.007)$</td>
<td>$-0.027 (0.006)$</td>
<td>$-0.020 (0.006)$</td>
</tr>
<tr>
<td>female</td>
<td></td>
<td></td>
<td></td>
<td>$0.184 (0.002)$</td>
</tr>
<tr>
<td>Asian</td>
<td></td>
<td></td>
<td></td>
<td>$0.429 (0.005)$</td>
</tr>
<tr>
<td>Black</td>
<td></td>
<td></td>
<td></td>
<td>$0.225 (0.006)$</td>
</tr>
<tr>
<td>Chinese</td>
<td></td>
<td></td>
<td></td>
<td>$0.556 (0.015)$</td>
</tr>
<tr>
<td>Mixed</td>
<td></td>
<td></td>
<td></td>
<td>$0.045 (0.005)$</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
<td>$0.403 (0.010)$</td>
</tr>
<tr>
<td>FSM</td>
<td></td>
<td></td>
<td></td>
<td>$-0.248 (0.003)$</td>
</tr>
<tr>
<td>age</td>
<td></td>
<td></td>
<td></td>
<td>$-0.012 (0.000)$</td>
</tr>
<tr>
<td>SEN</td>
<td></td>
<td></td>
<td></td>
<td>$-0.231 (0.003)$</td>
</tr>
<tr>
<td>IDACI</td>
<td></td>
<td></td>
<td></td>
<td>$-0.103 (0.001)$</td>
</tr>
<tr>
<td>LEA</td>
<td></td>
<td></td>
<td>$0.005 (0.001)$</td>
<td>$0.005 (0.001)$</td>
</tr>
<tr>
<td>Secondary</td>
<td></td>
<td>$0.065 (0.002)$</td>
<td>$0.043 (0.001)$</td>
<td>$0.035 (0.001)$</td>
</tr>
<tr>
<td>Primary</td>
<td></td>
<td>$0.035 (0.001)$</td>
<td>$0.025 (0.000)$</td>
<td></td>
</tr>
<tr>
<td>LSOA</td>
<td></td>
<td>$0.008 (0.000)$</td>
<td>$0.002 (0.000)$</td>
<td></td>
</tr>
<tr>
<td>Family (twin)</td>
<td>$0.238 (0.007)$</td>
<td>$0.168 (0.005)$</td>
<td>$0.157 (0.005)$</td>
<td></td>
</tr>
<tr>
<td>Pupil (twin)</td>
<td>$0.160 (0.003)$</td>
<td>$0.157 (0.003)$</td>
<td>$0.150 (0.003)$</td>
<td></td>
</tr>
<tr>
<td>Pupil (non-twin)</td>
<td>$0.468 (0.001)$</td>
<td>$0.402 (0.002)$</td>
<td>$0.383 (0.001)$</td>
<td>$0.357 (0.001)$</td>
</tr>
</tbody>
</table>

*Using MCMC; 450,500 iterations and a burn-in of 50,000*
## Results

<table>
<thead>
<tr>
<th></th>
<th>Model A</th>
<th>Model B</th>
<th>Model C</th>
<th>Model D</th>
</tr>
</thead>
<tbody>
<tr>
<td>cons</td>
<td>$-0.003 (0.001)$</td>
<td>$-0.003 (0.001)$</td>
<td>$0.001 (0.008)$</td>
<td>$-0.039 (0.007)$</td>
</tr>
<tr>
<td>twin</td>
<td>$0.177 (0.008)$</td>
<td>$0.179 (0.007)$</td>
<td>$0.162 (0.007)$</td>
<td>$0.154 (0.007)$</td>
</tr>
<tr>
<td>pretest</td>
<td>$0.730 (0.001)$</td>
<td>$0.729 (0.001)$</td>
<td>$0.701 (0.001)$</td>
<td>$0.641 (0.001)$</td>
</tr>
<tr>
<td>pretest.twin</td>
<td>$-0.040 (0.007)$</td>
<td>$0.000 (0.007)$</td>
<td>$-0.027 (0.006)$</td>
<td>$-0.020 (0.006)$</td>
</tr>
<tr>
<td>female</td>
<td></td>
<td></td>
<td></td>
<td>$0.184 (0.002)$</td>
</tr>
<tr>
<td>Asian</td>
<td></td>
<td></td>
<td></td>
<td>$0.429 (0.005)$</td>
</tr>
<tr>
<td>Black</td>
<td></td>
<td></td>
<td></td>
<td>$0.225 (0.006)$</td>
</tr>
<tr>
<td>Chinese</td>
<td></td>
<td></td>
<td></td>
<td>$0.556 (0.015)$</td>
</tr>
<tr>
<td>Mixed</td>
<td></td>
<td></td>
<td></td>
<td>$0.045 (0.005)$</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
<td>$0.403 (0.010)$</td>
</tr>
<tr>
<td>FSM</td>
<td></td>
<td></td>
<td></td>
<td>$-0.248 (0.003)$</td>
</tr>
<tr>
<td>age</td>
<td></td>
<td></td>
<td></td>
<td>$-0.012 (0.000)$</td>
</tr>
<tr>
<td>SEN</td>
<td></td>
<td></td>
<td></td>
<td>$-0.231 (0.003)$</td>
</tr>
<tr>
<td>IDACI</td>
<td></td>
<td></td>
<td></td>
<td>$-0.103 (0.001)$</td>
</tr>
<tr>
<td>LEA</td>
<td></td>
<td>$0.065 (0.002)$</td>
<td>$0.043 (0.001)$</td>
<td>$0.035 (0.001)$</td>
</tr>
<tr>
<td>Secondary</td>
<td></td>
<td></td>
<td></td>
<td>$0.035 (0.000)$</td>
</tr>
<tr>
<td>Primary</td>
<td></td>
<td></td>
<td></td>
<td>$0.025 (0.000)$</td>
</tr>
<tr>
<td>LSOA</td>
<td></td>
<td>$0.008 (0.000)$</td>
<td>$0.002 (0.000)$</td>
<td></td>
</tr>
<tr>
<td>Family (twin)</td>
<td>$0.238 (0.007)$</td>
<td>$0.168 (0.005)$</td>
<td>$0.157 (0.005)$</td>
<td></td>
</tr>
<tr>
<td>Pupil (twin)</td>
<td>$0.160 (0.003)$</td>
<td>$0.157 (0.003)$</td>
<td>$0.150 (0.003)$</td>
<td></td>
</tr>
<tr>
<td>Pupil (non-twin)</td>
<td>$0.468 (0.001)$</td>
<td>$0.402 (0.002)$</td>
<td>$0.383 (0.001)$</td>
<td>$0.357 (0.001)$</td>
</tr>
</tbody>
</table>

*Using MCMC; 450,500 iterations and a burn-in of 50,000*
Using MCMC; 450,500 iterations and a burn-in of 50,000
## Variance partitioning coefficients

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Twins</td>
<td>Non-twins</td>
</tr>
<tr>
<td>LEA</td>
<td></td>
<td></td>
<td>Twins</td>
<td>Non-twins</td>
</tr>
<tr>
<td>Secondary</td>
<td></td>
<td>13.9%</td>
<td>1.2%</td>
<td>1.1%</td>
</tr>
<tr>
<td>Primary</td>
<td></td>
<td>13.9%</td>
<td>10.3%</td>
<td>9.1%</td>
</tr>
<tr>
<td>LSOA</td>
<td></td>
<td>13.9%</td>
<td>8.4%</td>
<td>7.4%</td>
</tr>
<tr>
<td>Family</td>
<td></td>
<td>13.9%</td>
<td>1.9%</td>
<td>1.7%</td>
</tr>
<tr>
<td>Pupil</td>
<td></td>
<td>13.9%</td>
<td>59.8%</td>
<td>40.4%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>13.9%</td>
<td>40.2%</td>
<td>86.1%</td>
</tr>
</tbody>
</table>

### Research questions

1. How much of the shared environmental variation is due to family, school and area?
2. How much of the 'pupil' level variation in school effectiveness studies is really family level?
3. What happens when we try to explain some of the variation using pupil, family and LSOA level covariates?
### Research questions

1. How much of the shared environmental variation is due to family, school and area?
### Variance partitioning coefficients

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Twins</td>
<td>Non-twins</td>
</tr>
<tr>
<td>LEA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Secondary</td>
<td>1.2%</td>
<td>1.1%</td>
<td>1.3%</td>
<td>1.2%</td>
</tr>
<tr>
<td>Primary</td>
<td>13.9%</td>
<td>10.3%</td>
<td>9.1%</td>
<td>8.3%</td>
</tr>
<tr>
<td>LSOA</td>
<td></td>
<td>8.4%</td>
<td>7.4%</td>
<td>5.9%</td>
</tr>
<tr>
<td>Family</td>
<td></td>
<td>1.9%</td>
<td>1.7%</td>
<td>0.5%</td>
</tr>
<tr>
<td>Pupil</td>
<td>59.8%</td>
<td>40.4%</td>
<td>42.0%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>40.2%</td>
<td>37.7%</td>
<td>80.8%</td>
<td>40.1%</td>
</tr>
</tbody>
</table>

#### Research questions

1. How much of the shared environmental variation is due to family, school and area?  
2. How much of the ‘pupil’ level variation in school effectiveness studies is really family level?
## Research questions

1. How much of the shared environmental variation is due to family, school and area?

2. How much of the ‘pupil’ level variation in school effectiveness studies is really family level?
<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Twins</td>
<td>Non-twins</td>
</tr>
<tr>
<td>LEA</td>
<td></td>
<td></td>
<td>1.2%</td>
<td>1.1%</td>
</tr>
<tr>
<td>Secondary</td>
<td>13.9%</td>
<td>10.3%</td>
<td>9.1%</td>
<td>8.3%</td>
</tr>
<tr>
<td>Primary</td>
<td></td>
<td>8.4%</td>
<td>7.4%</td>
<td>5.9%</td>
</tr>
<tr>
<td>LSOA</td>
<td></td>
<td>1.9%</td>
<td>1.7%</td>
<td>0.5%</td>
</tr>
<tr>
<td>Family</td>
<td>59.8%</td>
<td>40.4%</td>
<td>42.0%</td>
<td></td>
</tr>
<tr>
<td>Pupil</td>
<td>40.2%</td>
<td>86.1%</td>
<td>37.7%</td>
<td>84.2%</td>
</tr>
</tbody>
</table>

**Research questions**

1. How much of the shared environmental variation is due to family, school and area?

2. How much of the ‘pupil’ level variation in school effectiveness studies is really family level?

What happens when we try to explain some of the variation using pupil, family and LSOA level covariates?
## Results

<table>
<thead>
<tr>
<th></th>
<th>Model A</th>
<th>Model B</th>
<th>Model C</th>
<th>Model D</th>
</tr>
</thead>
<tbody>
<tr>
<td>cons</td>
<td>−0.003 (0.001)</td>
<td>−0.003 (0.001)</td>
<td>0.001 (0.008)</td>
<td>−0.039 (0.007)</td>
</tr>
<tr>
<td>twin</td>
<td>0.177 (0.008)</td>
<td>0.179 (0.007)</td>
<td>0.162 (0.007)</td>
<td>0.154 (0.007)</td>
</tr>
<tr>
<td>pretest</td>
<td>0.730 (0.001)</td>
<td>0.729 (0.001)</td>
<td>0.701 (0.001)</td>
<td>0.641 (0.001)</td>
</tr>
<tr>
<td>pretest.twin</td>
<td>−0.040 (0.007)</td>
<td>0.000 (0.007)</td>
<td>−0.027 (0.006)</td>
<td>−0.020 (0.006)</td>
</tr>
<tr>
<td>female</td>
<td></td>
<td></td>
<td></td>
<td>0.184 (0.002)</td>
</tr>
<tr>
<td>Asian</td>
<td></td>
<td></td>
<td></td>
<td>0.429 (0.005)</td>
</tr>
<tr>
<td>Black</td>
<td></td>
<td></td>
<td></td>
<td>0.225 (0.006)</td>
</tr>
<tr>
<td>Chinese</td>
<td></td>
<td></td>
<td></td>
<td>0.556 (0.015)</td>
</tr>
<tr>
<td>Mixed</td>
<td></td>
<td></td>
<td></td>
<td>0.045 (0.005)</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
<td>0.403 (0.010)</td>
</tr>
<tr>
<td>FSM</td>
<td></td>
<td></td>
<td>−0.248 (0.003)</td>
<td></td>
</tr>
<tr>
<td>age</td>
<td></td>
<td></td>
<td>−0.012 (0.000)</td>
<td></td>
</tr>
<tr>
<td>SEN</td>
<td></td>
<td></td>
<td>−0.231 (0.003)</td>
<td></td>
</tr>
<tr>
<td>IDACI</td>
<td></td>
<td></td>
<td>−0.103 (0.001)</td>
<td></td>
</tr>
<tr>
<td>LEA</td>
<td>0.005 (0.001)</td>
<td>0.043 (0.001)</td>
<td>0.035 (0.001)</td>
<td>0.035 (0.001)</td>
</tr>
<tr>
<td>Secondary</td>
<td>0.065 (0.002)</td>
<td>0.035 (0.001)</td>
<td>0.025 (0.000)</td>
<td></td>
</tr>
<tr>
<td>Primary</td>
<td></td>
<td>0.035 (0.001)</td>
<td>0.025 (0.000)</td>
<td></td>
</tr>
<tr>
<td>LSOA</td>
<td>0.008 (0.000)</td>
<td>0.002 (0.000)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Family (twin)</td>
<td>0.238 (0.007)</td>
<td>0.168 (0.005)</td>
<td>0.157 (0.005)</td>
<td></td>
</tr>
<tr>
<td>Pupil (twin)</td>
<td>0.160 (0.003)</td>
<td>0.157 (0.003)</td>
<td>0.150 (0.003)</td>
<td></td>
</tr>
<tr>
<td>Pupil (non-twin)</td>
<td>0.468 (0.001)</td>
<td>0.402 (0.002)</td>
<td>0.383 (0.001)</td>
<td>0.357 (0.001)</td>
</tr>
</tbody>
</table>

*Using MCMC; 450,500 iterations and a burn-in of 50,000*
Summary

- Around a third of the family level variation in Model A is really school or area level (mostly school)
Summary

- Around a third of the family level variation in Model A is really school or area level (mostly school)
- Around half the pupil level variation in Model B is really family level

Caveats

- Our family effects are purely derived from twin pairs
- The twins are a mix of MZ and DZ so we are not estimating $\sigma^2_u + \sigma^2_g$
- Twins may be different to full sibling pairs
  - shared environment in the womb
  - they may elicit more similar environments
  - have same age sibling
- To what extent can we generalise to other family types?
  - e.g. single child families
Summary

- Around a third of the family level variation in Model A is really school or area level (mostly school)
- Around half the pupil level variation in Model B is really family level
- The covariates explain some variation at most levels
Summary

- Around a third of the family level variation in Model A is really school or area level (mostly school)
- Around half the pupil level variation in Model B is really family level
- The covariates explain some variation at most levels
- Family and pupil still make up the largest, roughly equal proportions of variation

Caveats

- Our family effects are purely derived from twin pairs
- The twins are a mix of MZ and DZ so we are not estimating $\sigma_u^2 + \sigma_g^2$
- Twins may be different to full sibling pairs
- They may elicit more similar environments
- Have same age sibling
- To what extent can we generalise to other family types?
  - e.g. single child families
Summary

- Around a third of the family level variation in Model A is really school or area level (mostly school)
- Around half the pupil level variation in Model B is really family level
- The covariates explain some variation at most levels
- Family and pupil still make up the largest, roughly equal proportions of variation
- Both school levels also remain important
**Summary**

- Around a third of the family level variation in Model A is really school or area level (mostly school)
- Around half the pupil level variation in Model B is really family level
- The covariates explain some variation at most levels
- Family and pupil still make up the largest, roughly equal proportions of variation
- Both school levels also remain important

**Caveats**

- Our family effects are purely derived from twin pairs

Caveats: Our family effects are purely derived from twin pairs. The twins are a mix of MZ and DZ so we are not estimating $\sigma^2_u + \sigma^2_g$. Twins may be different to full sibling pairs in the womb, they may elicit more similar environments if they have same-age sibling. To what extent can we generalise to other family types? For example, single-child families.
Summary

- Around a third of the family level variation in Model A is really school or area level (mostly school)
- Around half the pupil level variation in Model B is really family level
- The covariates explain some variation at most levels
- Family and pupil still make up the largest, roughly equal proportions of variation
- Both school levels also remain important

Caveats

- Our family effects are purely derived from twin pairs
- The twins are a mix of MZ and DZ so we are not estimating $\sigma_u^2 + \sigma_g^2$
- Twins may be different to full sibling pairs
  - they may elicit more similar environments when they have same age sibling
- To what extent can we generalise to other family types?
  - e.g. single child families
### Summary
- Around a third of the family level variation in Model A is really school or area level (mostly school)
- Around half the pupil level variation in Model B is really family level
- The covariates explain some variation at most levels
- Family and pupil still make up the largest, roughly equal proportions of variation
- Both school levels also remain important

### Caveats
- Our family effects are purely derived from twin pairs
- The twins are a mix of MZ and DZ so we are not estimating $\sigma_u^2 + \sigma_g^2$
- Twins may be different to full sibling pairs
Summary

- Around a third of the family level variation in Model A is really school or area level (mostly school).
- Around half the pupil level variation in Model B is really family level.
- The covariates explain some variation at most levels.
- Family and pupil still make up the largest, roughly equal proportions of variation.
- Both school levels also remain important.

Caveats

- Our family effects are purely derived from twin pairs.
- The twins are a mix of MZ and DZ so we are not estimating $\sigma_u^2 + \sigma_g^2$.
- Twins may be different to full sibling pairs.
  - They may elicit more similar environments.
  - They may have same age sibling.
- To what extent can we generalise to other family types?
  - E.g. single child families.
### Summary

- Around a third of the family level variation in Model A is really school or area level (mostly school)
- Around half the pupil level variation in Model B is really family level
- The covariates explain some variation at most levels
- Family and pupil still make up the largest, roughly equal proportions of variation
- Both school levels also remain important

### Caveats

- Our family effects are purely derived from twin pairs
- The twins are a mix of MZ and DZ so we are not estimating $\sigma^2_u + \sigma^2_g$
- Twins may be different to full sibling pairs
  - shared environment in the womb
  - they may elicit more similar environments
Interpretation

**Summary**
- Around a third of the family level variation in Model A is really school or area level (mostly school)
- Around half the pupil level variation in Model B is really family level
- The covariates explain some variation at most levels
- Family and pupil still make up the largest, roughly equal proportions of variation
- Both school levels also remain important

**Caveats**
- Our family effects are purely derived from twin pairs
- The twins are a mix of MZ and DZ so we are not estimating $\sigma_u^2 + \sigma_g^2$
- Twins may be different to full sibling pairs
  - shared environment in the womb
  - they may elicit more similar environments
  - have same age sibling

To what extent can we generalise to other family types? e.g. single child families
Interpretation

Summary
- Around a third of the family level variation in Model A is really school or area level (mostly school)
- Around half the pupil level variation in Model B is really family level
- The covariates explain some variation at most levels
- Family and pupil still make up the largest, roughly equal proportions of variation
- Both school levels also remain important

Caveats
- Our family effects are purely derived from twin pairs
- The twins are a mix of MZ and DZ so we are not estimating $\sigma_u^2 + \sigma_g^2$
- Twins may be different to full sibling pairs
  - shared environment in the womb
  - they may elicit more similar environments
  - have same age sibling
- To what extent can we generalise to other family types?
  - e.g. single child families
2. What happens under stress?
Variance functions for stress

Data
- Data is from previous cohort, who took GCSEs in 2006

Model

\[
\text{GCSE}_{ijk} = \alpha + \beta_1 \text{pretest}_{ijk} + \beta_2 \text{twin}_{jk} + \beta_3 \text{stressor}_{jk} + \nu_0 + \nu_2 \text{twin}_{jk} + \epsilon_2_{ijk} + \epsilon_4_{ijk} \text{twin} \cdot \text{stressor}_{jk} + \epsilon_6_{ijk} \text{nontwin} \cdot \text{stressor}_{jk}
\]
Variance functions for stress

Data

- Data is from previous cohort, who took GCSEs in 2006
- Postcodes with more than 2 students excluded

Model

\[
\text{GCSE}_{ijk} = \alpha + \beta_1 \text{pretest}_{ijk} + \beta_2 \text{twin}_{jk} + \beta_3 \text{stressor}_{jk} + v_0_k + u_2_{jk} \text{twin}_{jk} + e_2_{ijk} \text{twin}_{jk} + e_3_{ijk} \text{nontwin}_{jk} + u_4_{jk} \text{twin} \cdot \text{stressor}_{jk} + e_4_{ijk} \text{twin} \cdot \text{stressor}_{jk} + e_6_{ijk} \text{nontwin} \cdot \text{stressor}_{jk}
\]
Data
- Data is from previous cohort, who took GCSEs in 2006
- Postcodes with more than 2 students excluded
- Continuous variables not standardized

Model

Variance functions for stress
Variance functions for stress

Data
- Data is from previous cohort, who took GCSEs in 2006
- Postcodes with more than 2 students excluded
- Continuous variables not standardized

Stressors
- Our main stressor was IDACI, an LSOA level variable

Model
Variance functions for stress

Data
- Data is from previous cohort, who took GCSEs in 2006
- Postcodes with more than 2 students excluded
- Continuous variables not standardized

Stressors
- Our main stressor was IDACI, an LSOA level variable
- It aims to measure income deprivation affecting children

Model
Data
- Data is from previous cohort, who took GCSEs in 2006
- Postcodes with more than 2 students excluded
- Continuous variables not standardized

Stressors
- Our main stressor was IDACI, an LSOA level variable
- It aims to measure income deprivation affecting children
- Other stressors included:
  - FSM eligibility
  - House moves

Model

Variance functions for stress
Variance functions for stress

Data
- Data is from previous cohort, who took GCSEs in 2006
- Postcodes with more than 2 students excluded
- Continuous variables not standardized

Stressors
- Our main stressor was IDACI, an LSOA level variable
- It aims to measure income deprivation affecting children
- Other stressors included:
  - FSM eligibility
  - House moves

Model
\[ \text{GCSE}_{ijk} = \alpha + \beta_1 \text{pretest}_{ijk} + \beta_2 \text{twin}_{jk} + \beta_5 \text{stressor}_{jk} \]
\[ + \nu_{0k} + u_{2jk} \text{twin}_{jk} + e_{2ijk} \text{twin}_{jk} + e_{3ijk} \text{nontwin}_{jk} \]
\[ + u_{4jk} \text{twin} \cdot \text{stressor}_{jk} + e_{4ijk} \text{twin} \cdot \text{stressor}_{jk} \]
\[ + e_{6ijk} \text{nontwin} \cdot \text{stressor}_{jk} \]
Variance functions for stress

**Covariance structure**

\[
\begin{bmatrix}
v_{0k} \\
u_{2jk} \\
u_{4jk}
\end{bmatrix} \sim \mathcal{N} \left(0, \begin{bmatrix}
\sigma^2_{v0} \\
\sigma^2_{u2} & \sigma^2_{u4}
\end{bmatrix} \right)
\]

\[
\begin{bmatrix}
e_{2ijk} \\
e_{3ijk} \\
e_{4ijk} \\
e_{6ijk}
\end{bmatrix} \sim \mathcal{N} \left(0, \begin{bmatrix}
\sigma^2_{e2} & 0 & 0 & 0 \\
0 & \sigma^2_{e3} & 0 & 0 \\
0 & 0 & \sigma^2_{e4} & 0 \\
0 & 0 & 0 & \sigma^2_{e6}
\end{bmatrix} \right)
\]

**Model**

\[GCSE_{ijk} = \alpha + \beta_1 \text{pretest}_{ijk} + \beta_2 \text{twin}_{jk} + \beta_5 \text{stressor}_{jk} + v_{0k} + u_{2jk} \text{twin}_{jk} + e_{2ijk} \text{twin}_{jk} + e_{3ijk} \text{nontwin}_{jk} + u_{4jk} \text{twin} \cdot \text{stressor}_{jk} + e_{4ijk} \text{twin} \cdot \text{stressor}_{jk} + e_{6ijk} \text{nontwin} \cdot \text{stressor}_{jk}\]
Variance functions for stress

Covariance structure

\[
\begin{bmatrix}
  v_{0k} \\
  u_{2jk} \\
  u_{4jk} \\
  e_{2ijk} \\
  e_{3ijk} \\
  e_{4ijk} \\
  e_{6ijk}
\end{bmatrix} \sim N \left( 0, \begin{bmatrix}
  \sigma^2_{v0} \\
  \sigma^2_{u2} & \sigma^2_{u4} \\
  \sigma^2_{e2} & 0 & \sigma^2_{e4} & 0 & \sigma^2_{e6}
\end{bmatrix} \right)
\]

Model

\[
GCSE_{ijk} = \alpha + \beta_1 \text{pretest}_{ijk} + \beta_2 \text{twin}_{jk} + \beta_5 \text{IDACI}_{jk}
+ v_{0k} + u_{2jk} \text{twin}_{jk} + e_{2ijk} \text{twin}_{jk} + e_{3ijk} \text{nontwin}_{jk}
+ u_{4jk} \text{twin} \cdot \text{IDACI}_{jk} + e_{4ijk} \text{twin} \cdot \text{IDACI}_{jk}
+ e_{6ijk} \text{nontwin} \cdot \text{IDACI}_{jk}
\]
Results

Variance functions for
IDACI

- School
- Family
- Pupil
As IDACI increases,

We have this situation:

\[ \beta_5 = -6.8 \]

\[ \text{Progress} \]

\[ \text{IDACI} \]}
Interpreting the results

As IDACI increases,

- The mean progress decreases
  \[ \beta_5 = -68.1 \]

We have this situation:
Interpreting the results

As IDACI increases,

- The mean progress decreases
- $\beta_5 = -68.1$

We have this situation:

![Graph showing the relationship between IDACI and progress, with an downward trend line.]
As IDACI increases,

- **Between family** variation increases

- The **mean** progress decreases
  
  $\beta_5 = -68.1$

We have this situation:
As IDACI increases,
- Between family variation increases
- The mean progress decreases
  \[ \beta_5 = -68.1 \]
As IDACI increases,

- **Between family** variation increases
- **Within family** variation increases
- The **mean** progress decreases
  - \( \beta_5 = -68.1 \)

We have this situation:
As IDACI increases,

- **Between family** variation increases
- **Within family** variation increases
- The mean progress decreases
  - $\beta_5 = -68.1$

We have this situation:
Results

Variance functions for IDACI

- Orange line: family
- Blue line: pupil
- Yellow line: school

Variance vs. IDACI
As IDACI increases,
- **Between family** variation increases
- **Within family** variation increases
- The mean progress decreases
  - $\beta_5 = -68.1$

We have this situation:

Between family variation increases more dramatically than within family variation

So at greater levels of deprivation, family becomes relatively more important in determining progress
We fitted the same model with different stressors:
We fitted the same model with different stressors:
  - IMD

In almost all cases we see the same pattern.
We fitted the same model with different stressors:

- IMD
- FSM eligibility
We fitted the same model with different stressors:
- IMD
- FSM eligibility
- Ever moved house
We fitted the same model with different stressors:

- IMD
- FSM eligibility
- Ever moved house
- Number of house moves
Other stressors

- We fitted the same model with different stressors:
  - IMD
  - FSM eligibility
  - Ever moved house
  - Number of house moves
  - Time since house move
We fitted the same model with different stressors:

- IMD
- FSM eligibility
- Ever moved house
- Number of house moves
- Time since house move

In almost all cases we see the same pattern.
We fitted the same model with different stressors:
- IMD
- FSM eligibility
- Ever moved house
- Number of house moves
- Time since house move

In almost all cases we see the same pattern

We also fitted models with more than one stressor
Other stressors

- We fitted the same model with different stressors:
  - IMD
  - FSM eligibility
  - Ever moved house
  - Number of house moves
  - Time since house move

- In almost all cases we see the same pattern

- We also fitted models with more than one stressor
  - e.g. IDACI and FSM eligibility
Other stressors

- We fitted the same model with different stressors:
  - IMD
  - FSM eligibility
  - Ever moved house
  - Number of house moves
  - Time since house move

- In almost all cases we see the same pattern

- We also fitted models with more than one stressor
  - e.g. IDACI and FSM eligibility

- In these models, both stressors show the same pattern
We fitted the same model with different stressors:
- IMD
- FSM eligibility
- Ever moved house
- Number of house moves
- Time since house move

In almost all cases we see the same pattern.

We also fitted models with more than one stressor
- e.g. IDACI and FSM eligibility

In these models, both stressors show the same pattern.
### Genetic explanation
- **Some families** have genes which help to maintain progress in the presence of stressors, while others do not.

### Environmental explanation
### Genetic explanation

- **Some families** have genes which help to maintain progress in the presence of stressors, while others do not.
- In the absence of a stressor, the genes make little difference so there is not much variability.

### Environmental explanation
What’s going on? Possible explanations

Genetic explanation
- Some families have genes which help to maintain progress in the presence of stressors, while others do not.
- In the absence of a stressor, the genes make little difference so there is not much variability.
- In the presence of a stressor, the genes make a big difference so there is variability arising from the fact that some families have the gene and some don’t.

Environmental explanation
- Some families, across all levels of stressors, have factors that make it harder to be good parents.
- In the absence of stressors, even families with these factors can provide a good environment for progress.
- In the presence of stressors, families with these factors cannot do so → variability since some families have these factors and some don’t.
What’s going on? Possible explanations

Genetic explanation

- Within families, some children have genes which help to maintain progress in the presence of stressors, while others do not.
- In the absence of a stressor, the genes make little difference so there is not much variability.
- In the presence of a stressor, the genes make a big difference so there is variability arising from the fact that some children have the gene and some don’t.

Environmental explanation

- Some families, across all levels of stressors, have factors that make it harder to be good parents.
- In the absence of stressors, even families with these factors can provide a good environment for progress.
- In the presence of stressors, families with these factors cannot do so → variability since some families have these factors and some don’t.
What’s going on? Possible explanations

Genetic explanation
- **Within families, some children** have genes which help to maintain progress in the presence of stressors, while others do not.
- In the absence of a stressor, the genes make little difference so there is not much variability.
- In the presence of a stressor, the genes make a big difference so there is variability arising from the fact that some children have the gene and some don’t.

Environmental explanation
- **Some families**, across all levels of the stressors, have factors that make it harder to be good parents:
  - alcoholism of parent
  - violent spouse
What’s going on? Possible explanations

**Genetic explanation**
- **Within families, some children** have genes which help to maintain progress in the presence of stressors, while others do not.
- In the absence of a stressor, the genes make little difference so there is not much variability.
- In the presence of a stressor, the genes make a big difference so there is variability arising from the fact that some children have the gene and some don’t.

**Environmental explanation**
- **Some families**, across all levels of the stressors, have factors that make it harder to be good parents.
  - alcoholism of parent
  - violent spouse
- In the absence of stressors, even families with these factors can provide a good environment for progress.
What’s going on? Possible explanations

Genetic explanation
- Within families, some children have genes which help to maintain progress in the presence of stressors, while others do not.
- In the absence of a stressor, the genes make little difference so there is not much variability.
- In the presence of a stressor, the genes make a big difference so there is variability arising from the fact that some children have the gene and some don’t.

Environmental explanation
- Some families, across all levels of the stressors, have factors that make it harder to be good parents:
  - alcoholism of parent
  - violent spouse
- In the absence of stressors, even families with these factors can provide a good environment for progress.
- In the presence of stressors, families with these factors cannot do so → variability since some families have these factors and some don’t.
What’s going on? Possible explanations

**Genetic explanation**
- Within families, some children have genes which help to maintain progress in the presence of stressors, while others do not.
- In the absence of a stressor, the genes make little difference so there is not much variability.
- In the presence of a stressor, the genes make a big difference so there is variability arising from the fact that some children have the gene and some don’t.

**Environmental explanation**
- Children in families compete for resources.
What’s going on? Possible explanations

**Genetic explanation**
- **Within families, some children** have genes which help to maintain progress in the presence of stressors, while others do not.
- In the absence of a stressor, the genes make little difference so there is not much variability.
- In the presence of a stressor, the genes make a big difference so there is variability arising from the fact that some children have the gene and some don’t.

**Environmental explanation**
- **Children in families** compete for resources.
- In the absence of stressors, there are enough resources for the needs of all children.
What’s going on? Possible explanations

Genetic explanation

- Within families, some children have genes which help to maintain progress in the presence of stressors, while others do not.
- In the absence of a stressor, the genes make little difference so there is not much variability.
- In the presence of a stressor, the genes make a big difference so there is variability arising from the fact that some children have the gene and some don’t.

Environmental explanation

- Children in families compete for resources.
- In the absence of stressors, there are enough resources for the needs of all children.
- In the presence of stressors, there are fewer resources and some children will have their needs met while others will not → variability since those getting more resources can make more progress.


References


